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163

INDIAN JOURNAL OF POWER & RIVER VALLEY DEVELOPMENT

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VOL. VIII, NO. 1 JANUARY, 1958 RUPEES TWO

A VIEW OF THE KOYNA RIVER AND DAM SITE BEFORE CONSTRUCTION WORK

DATE DUE F-61
NOV 8 '78

See th

soothing brightness of Philips Fluorescent Lighting planned to perfection. They are happy because Philips light is so easy to work in, so cosy to live with. Even exacting jobs, like sewing or cooking, become a pleasure. Children play happily, men can relax with a sigh of pleasure.

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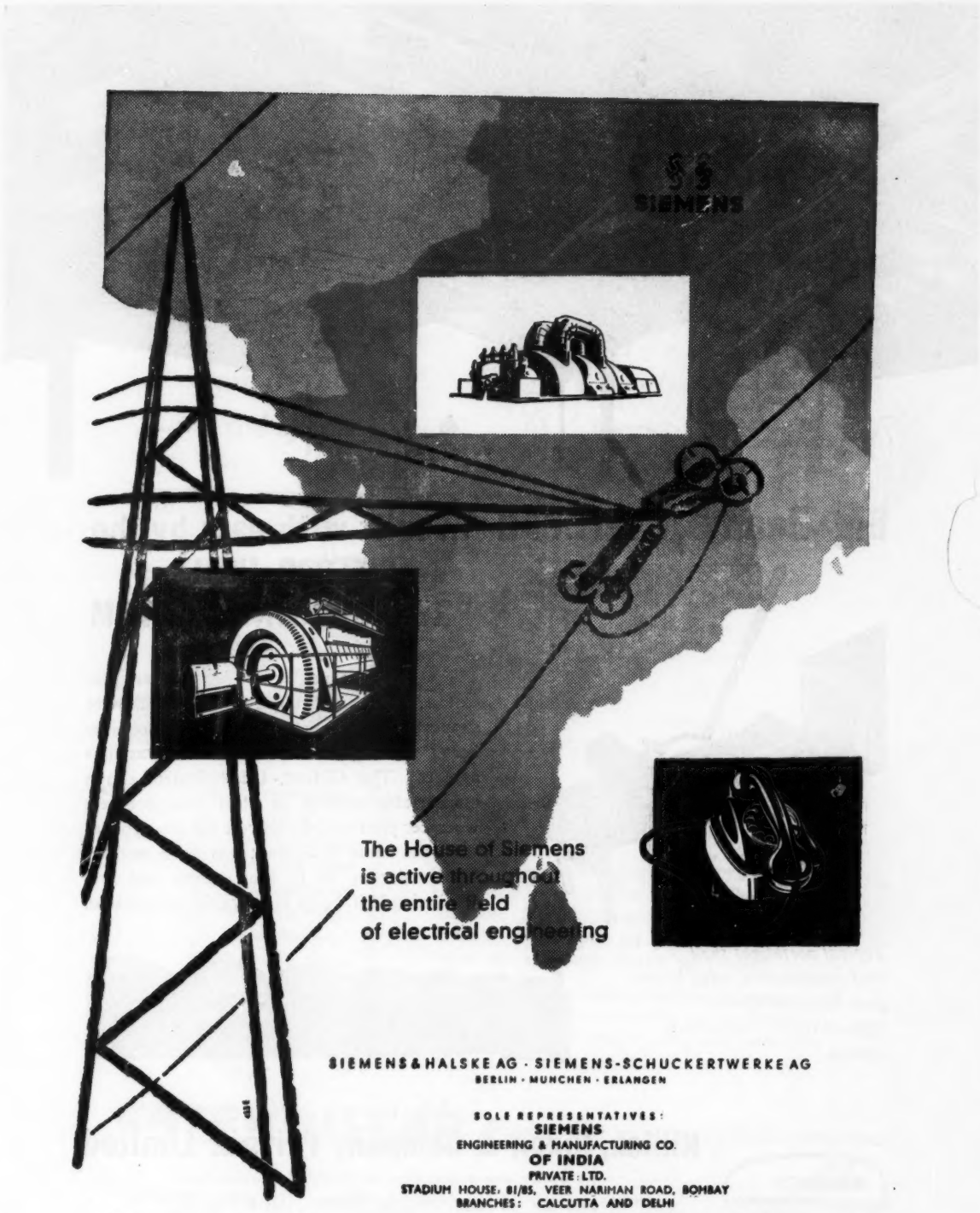

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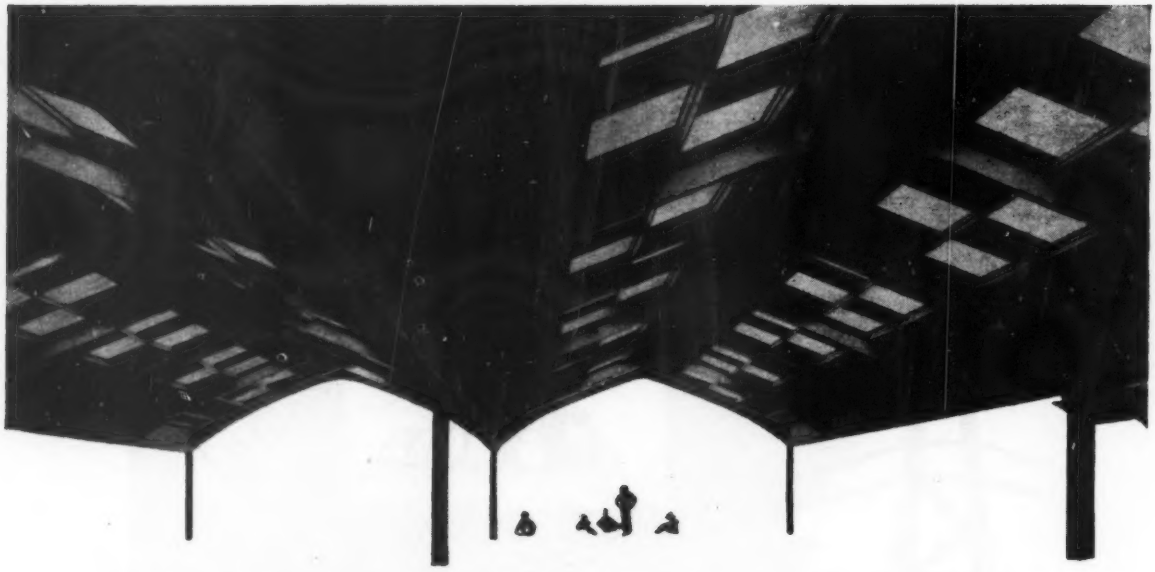

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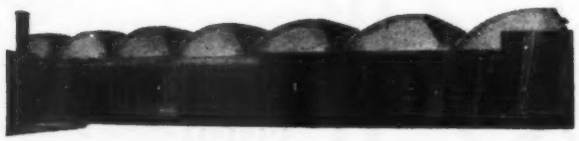
The primary beams for this factory were pre-cast in light, easily handled sections which were supported on false formwork before stressing: heavy and expensive lifting tackle was thus avoided. The Gifford-Udall System shows considerable savings in steel and concrete wherever pre-stressed concrete has an application; the same equipment has been used for post-tensioning 90 ft. span beams and pre-tensioning 30 ft. poles No royalties are payable.

Typical northlight shell roof construction; edge beams post-tensioned by the Gifford-Udall prestressing system.



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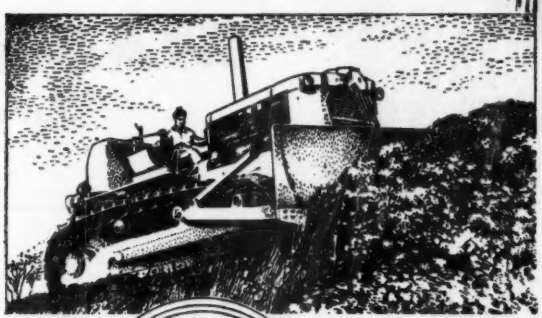
Tomorrow's fertile farmlands

can be built today by



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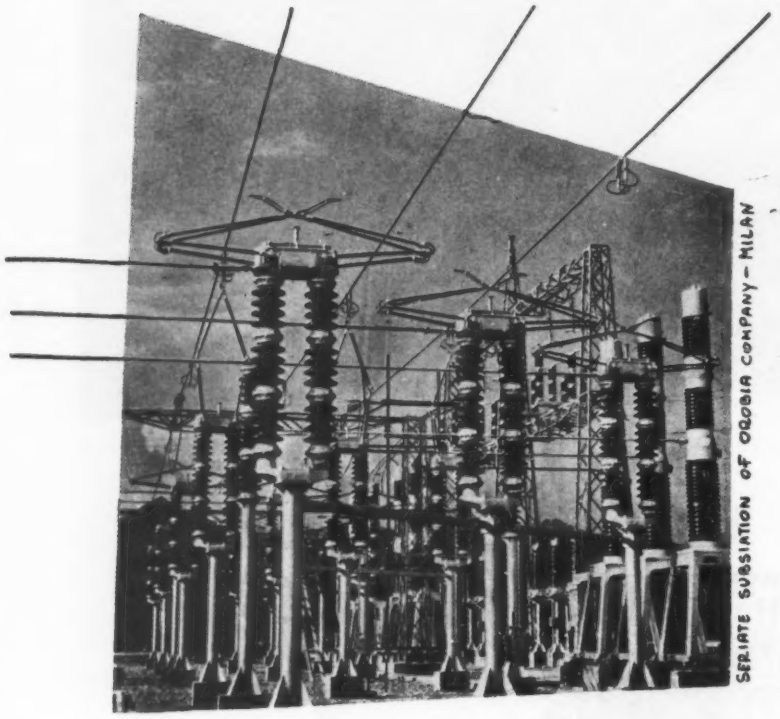

pantograph isolators

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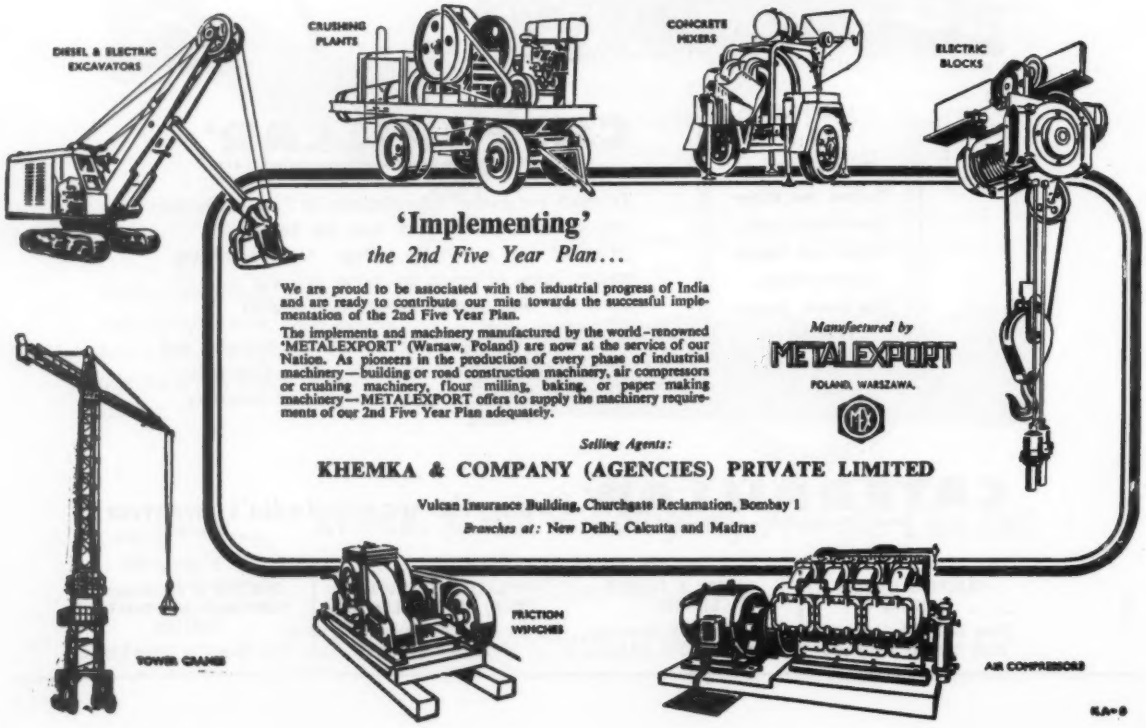

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We are proud to be associated with the industrial progress of India and are ready to contribute our mite towards the successful implementation of the 2nd Five Year Plan.

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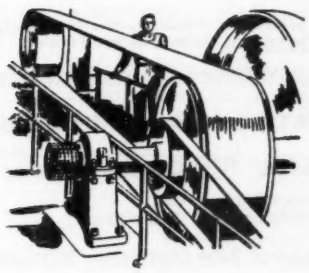

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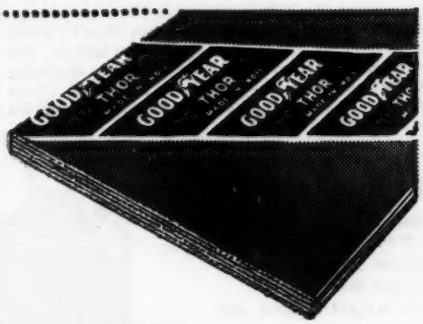
FOR EVERY DRIVE BY



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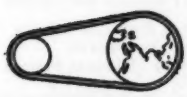

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Pg BATTERIES come to India

Patented construction prevents the most important cause of battery failure

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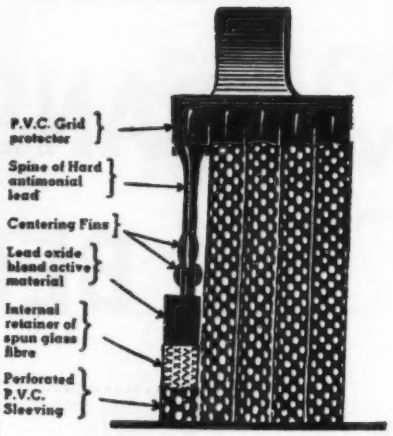
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The patented Pg Tubular Positive Plate, made in India exclusively by Standard Batteries Limited

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Standard — the first in batteries

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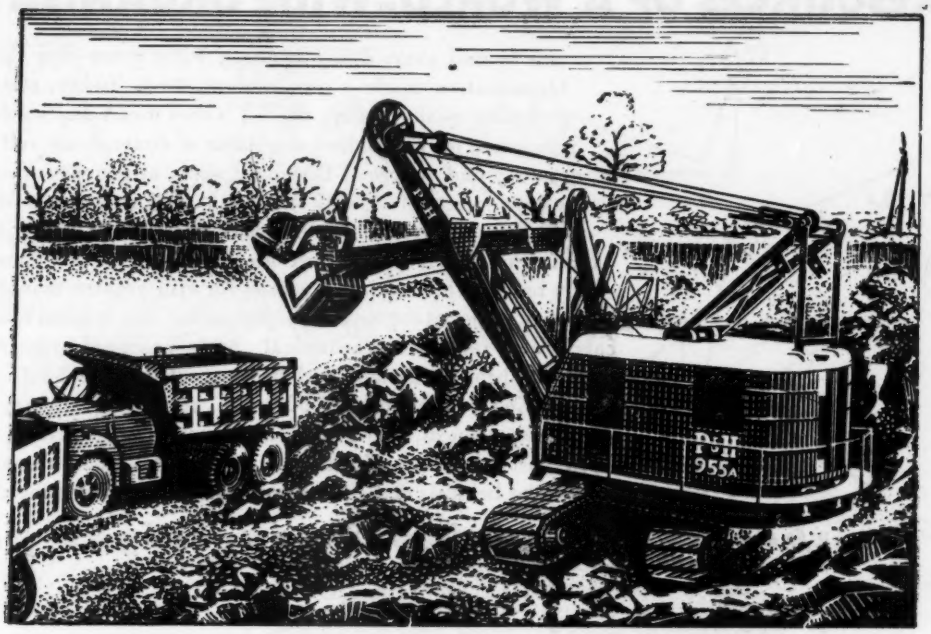

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In every corner of the country, P & H Excavators and Cranes are helping to establish the giant foundations of India's prosperity. Whether it's a dam or a power project... a steel plant or a strip mine... P & H are *on the job*—day and night.

Here's what you get with P & H equipment: Rugged construction and maximum mobility; easier operation and simplicity of control; increased output at lesser cost. P & H equipment are built to take it!

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are behind every SKF bearing. Fifty years ago the SKF Organisation made a very modest start. Today, steel of unsurpassed quality from SKF's own mines and steelworks, a reputation for the highest standards of dimensional and running accuracy and practical bearing designs of proven efficiency are the open secrets of SKF's success . . . and are reasons why today SKF is the world's leading manufacturer of roller bearings. SKF has 24 factories where machines and methods are continually being improved in the search for still greater manufacturing accuracy. Special engineering departments and modern laboratories carry out intensive theoretical and practical research into materials, bearing designs and bearing schemes. Behind all this is the combined experience of 50 years' service to industry and the transport systems of the world—experience which is readily available to *you* through over 150 SKF offices. All these resources and more will be behind SKF's future efforts to ensure the use of . . .

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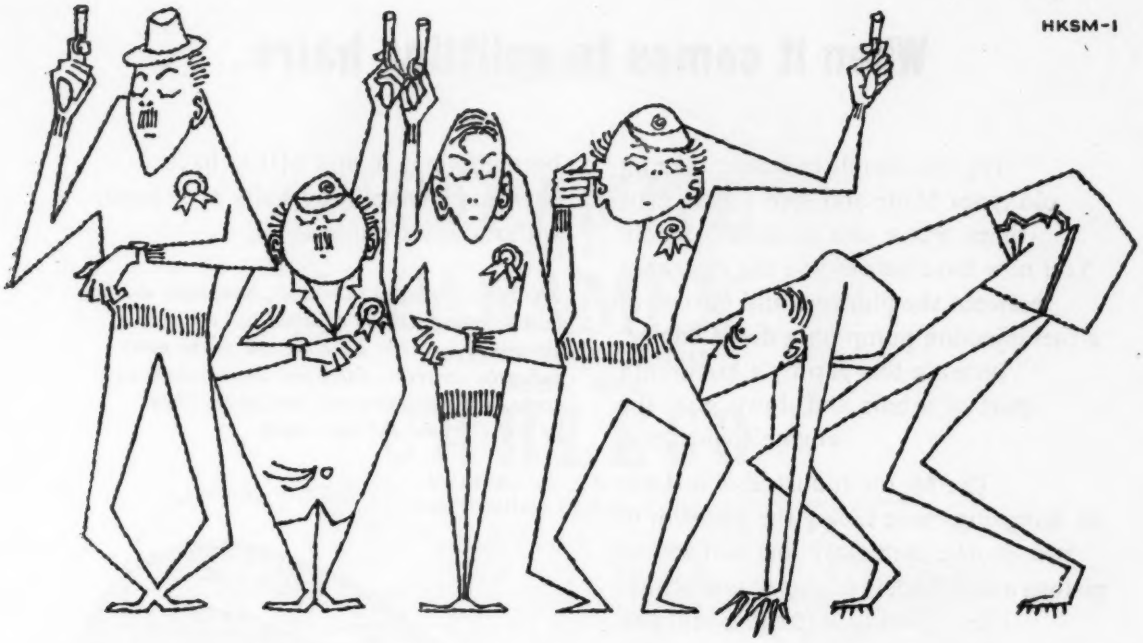

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TYPE SDO 15

Four starters and only one runner?

The illustration is ridiculous, of course, but there's a sort of moral to it:

We too have a fine line of starters...

TYPE COBI 15

TYPE COB 15

Not the kind up there, but those alongside: the push-button type; the sort of starters you're seeing more and more of in modern factories, workshops, mills etc. Ours is the famous H.K.S. line—a range of precision built, easily installed units which give continuous duty coupled with minimum servicing.

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Try this simple exercise: take an old razor blade and split a hair fifty times. Have you finished?...good. You now have before you the clearance between the plungers and barrels of a fuel injection pump on a diesel engine. Increase this gap by a hundredth part of a hair and down goes the engine's efficiency.

The Motor Industries Co. Ltd.. in Bangalore were facing the problem of rust on the incredibly fine surfaces of pistons and cylinders during manufacture. They called in Burmah-Shell, and our technical people developed a special rust preventive for the job: B.O.C. R.P. Compound 'A'.

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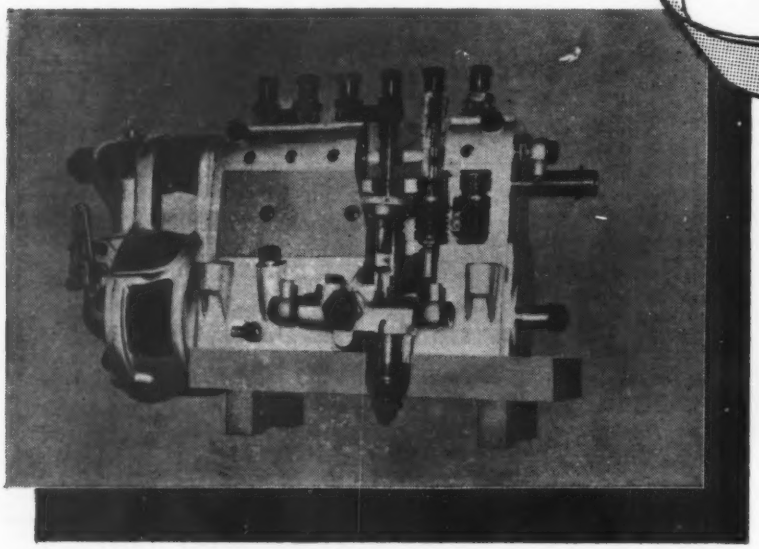

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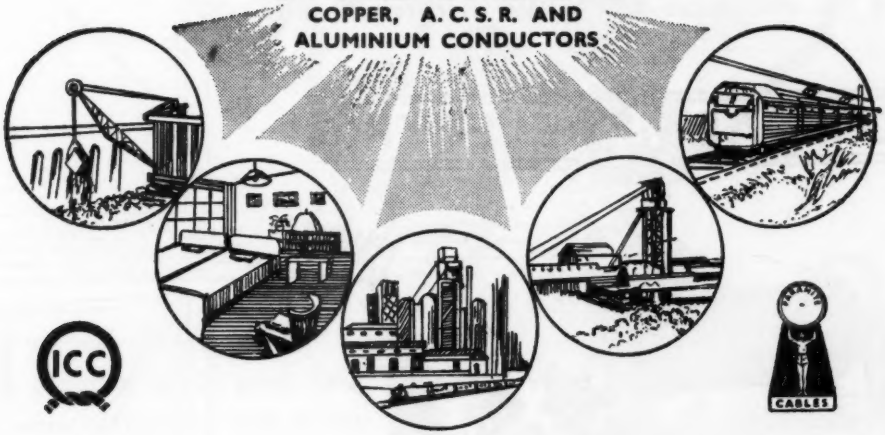

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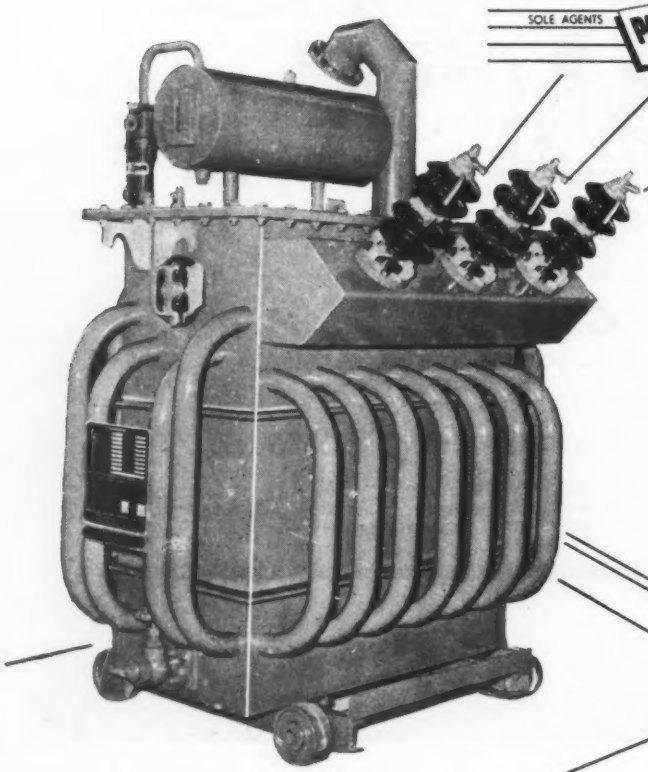

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...Key to INDIA'S Future

Huwood Conveyors are playing their part in the construction of the many dams now being built across the Indian rivers — dams which have the purpose of combining irrigation with the production of cheap electric power. Dam construction is testing work for the conveyors employed .. contractors must be sure of obtaining equipment which is both reliable and exactly adapted to their needs.

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Direct lift capacity 1½ tons. Maximum 6 tons.

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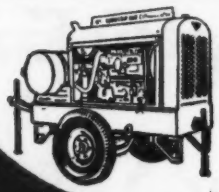

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The versatile and revolutionary tool that saves the cost of buying and maintaining many one-purpose units. Works fast as Crane, back hoe, Shovel dragline Clamshell, Magnet Crane, Pile driver, backfiller Grapple.

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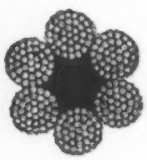

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GLAHOLM & ROBSON LTD.

Messrs. Glaholm & Robson are manufacturers of the highest quality steel wire ropes for Mining, Engineering and Shipping purposes. All ropes are made throughout entirely from British Steel and are subject to the most severe tests before leaving the manufacturer's works.

Messrs. Lloyds' certificates can be furnished if desired.

Please write for information and price to the Agents :

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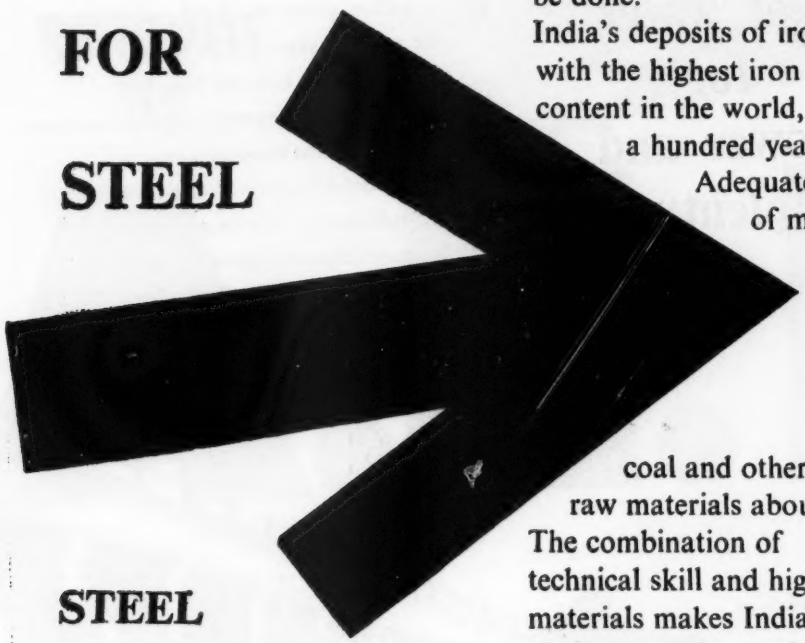
TARGETS FOR STEEL



STEEL IS THE STARTING POINT

Use steel only when you must today, there will be more tomorrow.

Six million tons a year is India's immediate target for steel—the absolute minimum for her present needs.
Eighteen million tons is the target for the Third Five Year Plan—it can be done.
India's deposits of iron ore, with the highest iron content in the world, can last a hundred years.
Adequate supplies of metallurgical coal and other raw materials abound.
The combination of technical skill and high quality materials makes India the world's cheapest producer of steel.
IISCO'S immediate target—eight hundred thousand tons of finished steel and two hundred and eighty thousand tons of pig iron.

INDIAN IISCO STEEL

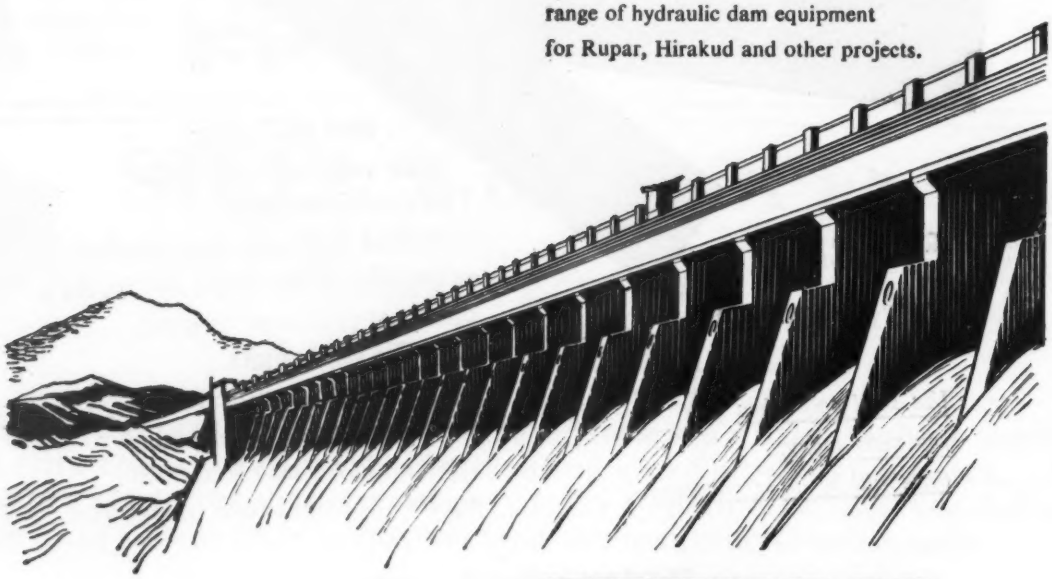
THE INDIAN IRON & STEEL CO. LTD.
Works: Burnpur and Kulti
Head Office : 12, Mission Row, Calcutta.

IIC-62

FACTS BEHIND FIGURES

171 million acre feet water for power and plenty

Astride India's rivers are rising mighty dams to bring power and plenty to the nation. With the completion of the major Plan projects, 171 million acre feet of India's river water will be harnessed. The new river valley schemes will release 2,000,000 KW power and irrigate 16 million acres. The total expenditure on irrigation, power and flood control during the next five years will be Rs. 913 crores, a 38% increase over the First Plan. These great development schemes constitute one of the most important aspects of the nation's efforts to achieve economic self-sufficiency. Texmaco, pioneer in many fields of engineering, working in technical collaboration with Voest of Linz, Austria, has constructed a wide range of hydraulic dam equipment for Rupar, Hirakud and other projects.



TEXMACO

serves India's basic industries

TEXTILE MACHINERY CORPORATION LIMITED

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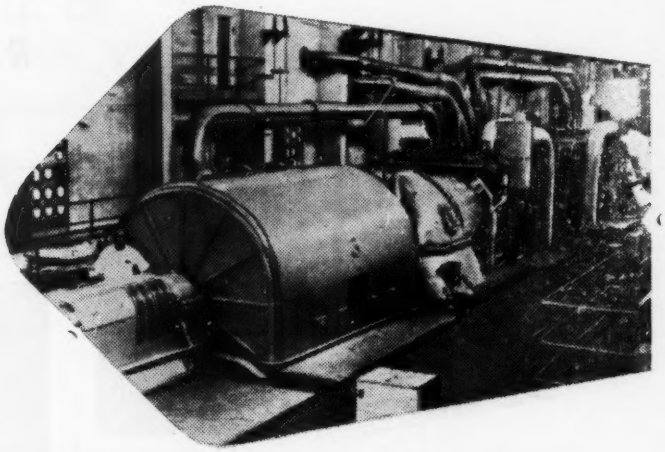
Power for the Millions by



A.E.I.

Khaperkheda	30,000 KW
Ramgundam	37,500 KW
Ahmedabad	1,35,000 KW
Surat	15.000 KW
Visakhapatnam	6,750 KW
Tatanagar	55,000 KW
Kashmir	6,000 KW
Jogindarnagar	48,000 KW
Greater Calcutta	1,61,000 KW
Madras (Basin Bridge), Pykara, Mettur, Papanasam and Moyar	2,15,450 KW
Mysore (Jog)	48,000 KW
Travancore	22,500 KW
U. P. (Harduagang), Bahadrabad, Bhola, Sumera & Muhammadpur	40,600 KW
Bhakra dam *	500,000 KVA

* *Plant under manufacture*

Each symbol indicates major generating plant, hydro and steam, supplying grid transmission lines. Generating plants of the capacity listed have been supplied and installed by A.E.I.

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THE BRITISH THOMSON HOUSTON CO. LTD.
FERGUSON PAILIN LTD.
THE HOTPOINT ELECTRIC APPLIANCE CO. LTD. (Coldrator and Premier Divisions)
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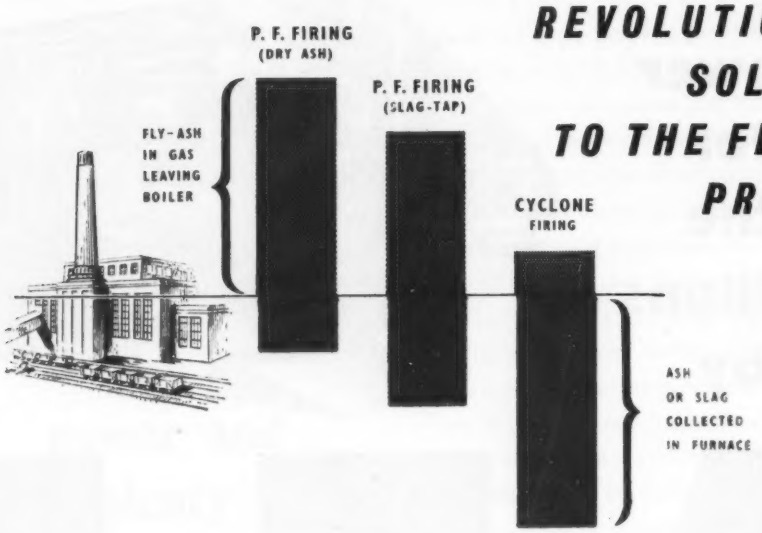

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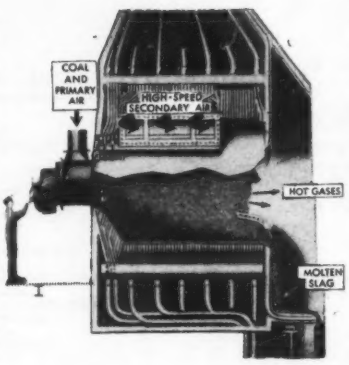

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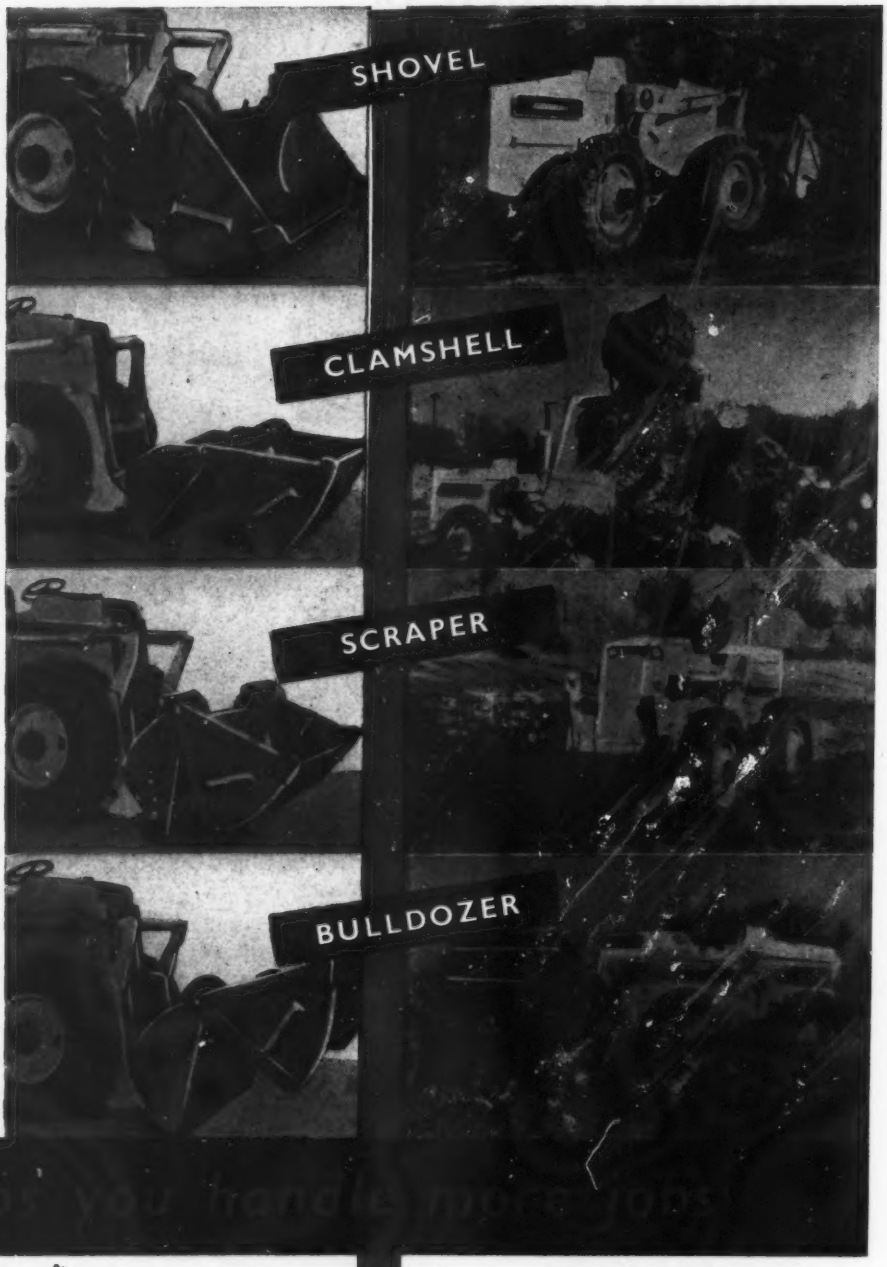

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Kosi Project

By J. BAHADUR

Regular survey and investigations, with a view to formulate a scheme to tame the Kosi, were commenced by the Central Waterways Irrigation and Navigation Commission only from 1946. A plan was then prepared in 1950 which included the construction of a 783-feet high dam about a mile above the sacred temple of Barahkhetra in Nepal together with a powerplant to generate 1.8 millions k.W., a barrage across the river at Chatra for diverting supplies for irrigation, canals on either side and also some measures for soil conservation. The cost of the project was estimated as 177 crores and was to be constructed in seven stages. The Government of India, appointed a committee to go into details and examine the desirability or otherwise of the proposals. This committee felt that the scheme was not quite sound from the economic point of view in the initial stages and even after completion it could be remunerative only if the large block of power could find a ready use. Besides, it would not give the immediate flood relief which was required.

The committee therefore suggested the construction of a low dam 85 feet high at the nose of Belka hill, 9 miles below Chatra with a power plant to generate 68,000 k.W. and an irrigation system irrigating both sides in Nepal and Bihar. But investigations at the dam site proved that a low dam at Belka would not be possible as the river bed had only fine sand to indefinite depth. The scheme had to be dropped once again.

The river conditions were however continued to be studied further; silt and hydraulic data were collected and the river gradient investigated. It was noticed the percentage of coarse silt content in the Kosi was much higher than in other Himalayan rivers. The average annual suspended sediment load appeared to be 99,800 acre feet containing coarse sediment as 16%, medium sediment 28% and fine sediment 56%. The river gradient is sharp from Chatra, at the foothills of the Himalayas, to Hanumannagar near Indo-Nepal boundary. It is about 4 feet per mile. Below Hanumannagar, the gradient becomes flat and large volumes of coarse silt get deposited, sand bars and shoals are formed and the river starts spreading out and cutting new courses.

Present Scheme

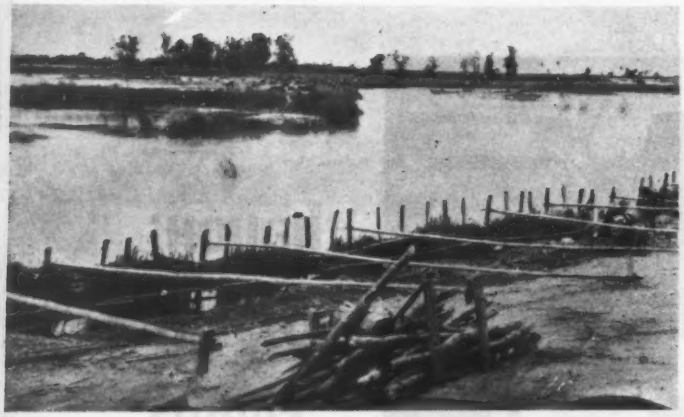
So, with the data collected and hydrological studies carried out, a new scheme was prepared by the Central Water and Power Commission at an estimated cost of Rs. 37.32 crores. This estimate had however to be revised on the basis of further investigations and experience gathered in the field and the amount now stands at Rs. 45.6 crores. A provision of Rs. 1.32 crores has further been made for civil works connected with power generation. The Project consists of four different units as follows :—

(*a*) Unit I—Hanumannagar Barrage and Head Works : This is estimated to cost Rs. 16.79 crores. The barrage is to be constructed about 30 miles below Chatra in Nepal where the river debouches into the plains from the gorge. It consists of a concrete spillway 3769 ft. long with earth dams about 12,000 feet each on both the flanks connected to two Afflux Bunds 8 miles each on either banks of the river. The functions of the barrage are (*i*) to arrest coarse silt and flatten the gradient of the river above (*ii*) to provide for irrigation of 14 lakh acres and (*iii*) to develop power that is possible with the available head. (The earthquake safety factor adopted in the design of the Barrage is .15g horizontal and .10g vertical)

(*b*) Unit II—Flood Banks and Protective Measures : The estimated cost for this is Rs. 13.07 crores involving construction of 75 miles of embankment on the western side below barrage and 63 miles on the eastern side. Besides, a flood bank of 12 miles above the East Afflux Bund in continuation is also provided. The purpose is to restrict the flood waters between the embankments, thus preventing the usual spill, and also to stop further westward translation of the river Kosi.

(*c*) Unit III—Eastern Kosi Canal System : The canal system at an estimated cost of Rs 15.74 crores is proposed to have an annual irrigation of about 14 lakh acres in the districts of Purnea and Saharsa.

(*b*) Unit IV—Hydro Electricity : A provision of Rs. 1.32 crores has been made for this. It is expected about 20,000 k.W. can be generated, but the exact scheme is yet to be finalised.



Spurs have been provided for the protection of the embankment. Near Supaul some people are seen engaged in repairing the spurs.

Commencement of works

Following the decision in November, 1954, to implement the Kosi Project plan as formulated by the Central Water and Power Commission in 1953, the flood banks were taken up for construction first and work near Nirmali on the Western Embankment was inaugurated by the Chief Minister of Bihar on 14th January, 1955, the Makar Sankranti day. The work on Eastern Embankment near Supaul was commenced on 3rd February, 1955.

Progress

(*a*) Roads : An access road 26 miles long connecting Bathnaha the nearest railhead on the North Eastern Railway with Bhimnagar the Barrage site has been formed. For 23 miles i.e. upto Birpur the road has been opened to traffic. The road had to be provided with nine bridges and as this would have taken quite a long time, temporary wooden ones were first erected to serve the purpose. The pucca bridges were taken up later and these also are now nearing completion. Besides these bridges, 53 culverts have also been completed. Work on the road is going on vigorously and most of the work in expected to be finally completed very shortly.

(*b*) Railways : Construction materials like coarse aggregate, riprap, rockfill and filter have to be obtained from natural deposits near Chatra and Dharan Bazar on the foothills of Nepal terai which are far away from the Barrage site. So a N.G. railway scheme has been undertaken. A total of 48 track miles is involved. The railway embankment has been completed for 21 miles and rail linking on this portion done. Further earthwork in the other reaches is in progress.

In order to provide increased facilities of transport between Bathnaha and Bhimnagar, another N.G. Railway communication is to be operated on the berm of the access road. Rail linking has been done between Bathnaha and Birpur and trial runs already taken.

One hundred railway wagons for conveying coarse aggregate etc. have been acquired from Japan and they have reached the work site. Twenty old locomotives are proposed to be acquired from Indian Railways.

(*c*) Colonies : The main colony of the Project to serve as headquarters is located at Birpur 4 miles from Bhimnagar the Barrage site. At this place 455 quarters of different types and 21 barracks have been completed and more are in progress. In the non-residential type, 8 nos. of Twin nissen huts, 8 nos. of store sheds, 2 M.B. sheds, 8 tubular structure offices and an Inspection Bungalow class III have been completed. An Inspection Bungalow Class I has also been completed. A pucca landing strip is under construction and a temporary landing ground is already being maintained to serve for the meanwhile.

Colonies have also been planned at Bathnaha where 57 quarters have been completed, Bhimnagar where 32 quarters have been completed, and Dharan Bazar where 42 quarters have been completed.

Canal colonies at Khataia and Pratapganj are also under way and 11 quarters have been constructed in the former.

(*d*) Barrage : The work in respect of the Hanumannagar Barrage has been limited to investigations, planning and procurement of machines together with finalisation of designs and drawings by the Central Water and Power Commission. Last year, there was a decision to let out the whole work on contract and tenders were invited for construction of the Barrage. The response, however, was very poor and the only tender received for construction of the Barrage as a whole exceeded the estimate by nearly cent per cent. It has, therefore, been decided to take up the work mainly departmentally. A number of earthmoving machines have already been acquired. Screening plant has been got from the Damodar Valley Corporation and has been installed in the coarse aggregate quarry. Sixteen sump wells for pumping have been sunk at the Barrage site and more are being sunk.

Collection of quarry materials was done by manual labour to the extent possible. A total of 5.9 lakh cft. of rip rap, rockfill and filter materials have been collected.

A workshop has already been set up at Birpur on a small scale and will be gradually enlarged as machines are acquired. Generating sets, one of 250 k.W. and another of 100 k.W. have been installed at Birpur for power supply. A bigger power house is under construction. The power plant from Tilaiya (D.V.C.) is being transferred and will be installed in this.

Sramdaeies bringing earth on Embankment near Madhapur

Preparations are being made to commence work in the Barrage in the current working season. It is proposed to take up about 275 feet length of the concrete spillway and complete the raft and piers.

(*e*) East Afflux Bund : Afflux Bunds upstream of the Barrage on both sides have to be provided to create the pond. The Afflux Bund on the eastern side which is in a low region has been taken up and about 7½ crores cft. of earthwork has been already done representing an overall progress of 91%.

(*f*) Eastern Earth Dam : This is 12,000 feet in length and is located across the river on its eastern flank in continuation of the concrete spillway and head regulator connecting these with the East Afflux Bund.

The work has started and substantial progress is expected during the current season.

(*g*) Canals : The main canal is to take off from the eastern side of the Barrage and feed the four branch canals viz. Supaul Branch, Pratapganj Branch, Purnea Branch and Araria Branch. The canal system is planned to have an annual irrigation of about 1·4 lakh acres.

The scheme is in the investigation stage. Detailed survey and investigations for the full length of main canal of 26 miles has been completed and earthwork in excavation of the canal in 3rd to 4th reaches also started. Similar work in respect of 44 miles of Supaul branch and 56 miles of Pratapganj branch has also been done. Preliminary investigations for distributaries has also been started. 9 miles of Supaul branch distributaries have been aligned.

Other miscellaneous items of work e.g. working out hydraulic particulars, formulating proposals for cross drainage works and designing them, preparing detailed drawings, estimates etc. remained in progress.

(*h*) Embankments : Construction of Kosi Embankments was started on 4th January, 1955. The third working season for the embankments has just ended. The Western Embankment below barrage is 75 miles in length and the Eastern Embankment 63 miles.

A group of Dumpers loaded with earth passing on way to unload the same at Afflux Bundh near Belhi near the Barrge site.

Labourers engaged in setting the n. g. railway line ready for running the train on works Sursahardhar
The n. g. railway line has become necessary for the transport of construction materials to the barrage site at Bhimnagar.

Besides, a flood bank of 12 miles above the East afflux Bund in continuation is also provided. During the first two working seasons, earthwork in 106 miles of embankments on both the banks of Kosi was done out of a total of 150 miles. About 47½ crore cft. of earthwork was turned out entirely by manual labour

During the outgoing working season (1956-57), the idea was to complete the residual work in the old reaches and also the remaining lengths on the eastern and western side totalling 44 miles. A total of about 23.7 crore cft. of earthwork had to be done so as to complete the above. But due to continued water-logging of borrow areas with high water table of the region till December, 1956 and stiff opposition of the villagers regarding alignment of the new reaches that continued till March, 1957, a total of 12.4 crore cft. could only be done. The cumulative output in all the three seasons is now about 85% and 15% has to be done during the current season.

The agency-wise output of earthwork on the embankments upto the end of June, 1957 (exclusive of East Afflux Bund) is as follows :—

Name of agency	*Total output in lakh cft. (Cumulative)*
Shramdan	21.29
Homeguards	6.38
A.C.C. & N.C.C.	40.49
Gram Sewaks	6.84
Nepal Labour Societies	88.10
Public Co-operation	2236.81
Contractor	3589.67
Total	5989.58

Male and female labourers engaged in the construction of Sluice gate near Bangama on Western Embankment near Nirmali.

There are a number of sluices to be constructed at appropriate places, specially on the western side as the slope of the country is generally from North West to South East and several *dhars* join the Kosi on its western bank. All the 27 nos. of sluices on the western side are in good progress and except one the rest have generally been completed. A further 7 nos. of sluices are to be provided on the Eastern Embankment also 3 of these are for irrigation and the other 4 for drainage. These will be taken up during the next working season. (*i*) Collection of basic data : Gauge and discharge observations, silt observations, mateorological and seismological observations are being carried out regularly. Bed material sampling and survey of the river is also being done. (*j*) Soil Conservation : In accordance with a pilot scheme formulated by the Central Water and Power Commission some soil conservation works were started in the upper reaches. A number of spurs and check dams besides other soil conservation measures like slope pitching, gully plugging, etc were undertaken.

Further work is to be continued. Reconnaisance of the area above Tribeni confluence along Sun Kosi, Arun and Tamur, the tributaries of Kosi, to locate a suitable site for a dam has been done.

Salient features

(*i*) *River Flow*

1. Catchment area of Kosi upto Barrage site.	23,858 sq. miles.
2. Maximum flow estimated	9,50,000 cusecs.
3. Maximum flow observed (1954)	8,60,000 ,,
4. Minimum flow observed (1948)	9016 ,,
5. Mean annual run off	43 million acre feet

(*ii*) *Concrete spillway*

Main Spillway

(*a*) Designed discharge	9,50,000 cusecs.
(*b*) Length	3769 ft.
(*c*) Crest level	El 235.00 feet.
(*d*) Gates 50 nos. of 60 ft. $\times 27\frac{1}{2}$ ft.	$\times 22\frac{1}{2}$ ft. & 6 nos. of 60 ft.

(*iii*) *Earth dams*

Eastern portion	12,000 feet.
Central portion	1,000 feet.
Western portion	12,000 feet.
Crest level	El 265.00 ft.

(*iv*) *Afflux Bund*

Western	8 miles
Eastern	8 miles

(*v*) *Pond*

Present Normal pond level	El 245.00 feet.
Present max. Water level	El 252.50 feet.
Future normal pond level	El 255.00 feet.
Future max. Water level	El 257.50 feet.
Area of pond at El 255.00	11,330 acres.

Capacity of pond at El 255.00 (taking back water into consideration) 99,370 acre feet.

(*vi*) *Embankments*

1. Below Barrage

(*a*) *Western embankment*

(*i*) Bharda to Jhamta	$63\frac{1}{2}$	miles.
(*ii*) Ring bunds (Nirmali to Mahadeomath)	$7\frac{1}{2}$	miles.
(*ii*) Marginal embankments (Tiljuga and Bhutahi Balan)	$4\frac{1}{2}$	miles.
	$75\frac{1}{2}$	miles.

(*b*) *Eastern Embankment*

(*a*) Bhimnagar to Mahisi 63 miles.

2. *Above Barrage.*

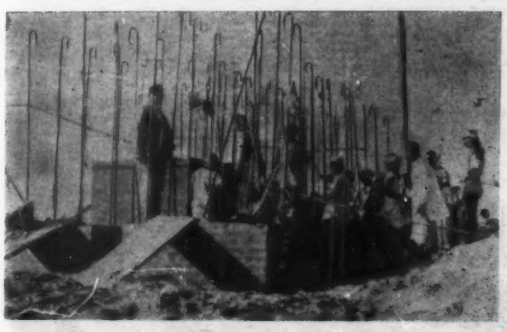
Eastern flood embankment above Afflux Bund 12 miles.

Overall length $150\frac{1}{2}$ miles involving 72 crore cft.

(*vii*) *Irrigation System*

Gross comanded area	18.23 lakh acres.
Culturable area	12.15 lakh acres.
Annual irrigation	13.97 lakh acres.

Coolies engaged in Bridge construction at Bochaha near Birpur (side view).



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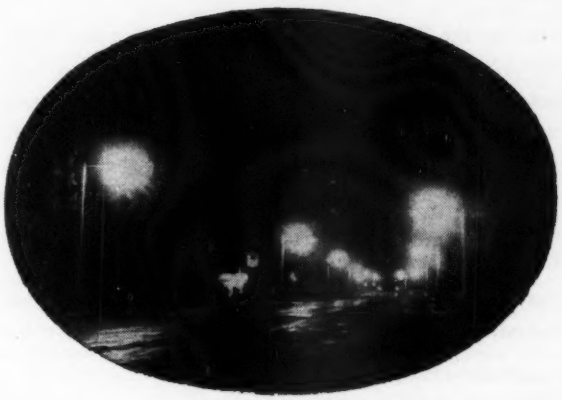

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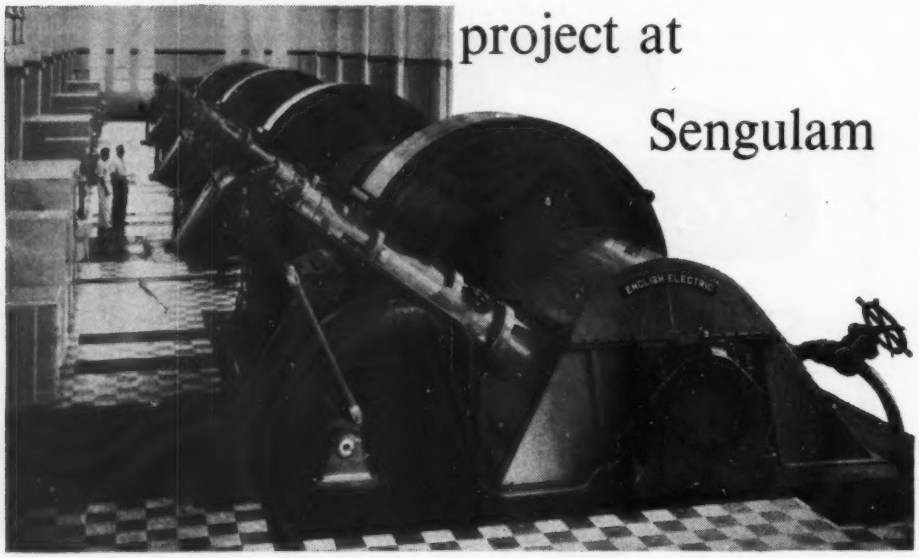

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Nagarjunasagar Project

The Nagarjunasagar Project will be a huge undertaking compared to other river valley projects in India. Its ultimate storage capacity of 9.30 million acre ft., as compared to 7.4 million acre ft. at Bhakra, will be the largest for any single dam in India. The dam will be the second highest in the country, next only to the Bhakra dam. The masonry work involved will again be stupendous. More than 190 million cubic ft. of masonry and concrete will have to be done ultimately, compared to 140 million cubic ft. to be done at Bhakra. The total draw-off by the canals on both sides from the reservoir will be ultimately 3600 cusecs, the biggest for any reservoir in India—the discharge capacity of the Right Canal alone, *viz.* 21,000 cusecs, will make it the biggest irrigation canal in the world.

The project was commenced during 1955-56 as a joint scheme of the then Andhra and Hyderabad States for the utilisation of the available water of the Krishna river in the lower Krishna basin. In this basin, there are wide areas where the rain-fall is precarious, erratic and flashy. Within this catchment lies a larger extent of scarcity affected area than could be found in any other river basin in India. The Krishna basin lies chiefly under the influence of the South-West monsoon and it brings as much as a million cusecs of water from June to October—the maximum discharge is twice as much as that of the Nile or the Cauvery. This is a typical Deccan river and in the summer, it dwindles down sometimes to 100 cusecs. The annual dependable flow at Vijayawada is approximately 1715 T.M. Cft., of which the existing utilisation is about 27 per cent. Works to utilise another 17 per cent are under construction in the States of Bombay, Mysore and Andhra Pradesh. The balance flow of the river has been alloted to the various States at the inter-State Conference convened by the Planning Commission in 1951. The Nagarjunasagar project will ultimately utilise about 464 T.M.Cft., to irrigate the arid lands of Guntur, Kurnool and Nellore districts on the right side and Nalgonda, Khammam, Krishna and West Godavari districts on the left side. The project under sanction will, however, utilise 306 T.M.Cft., and serve Palnad Sattanapalli, Vinukonda, Narasaraopet, Guntur, Bapatla and Ongole taluks (Guntur district) and Markapur taluk (Kurnool Dist) under the Right Canal, and Miryalguda and Huzurnagar taluks (Nalgonda district), Khammam taluk (Khammam district) and Nandigama taluk (Krishna district) under the Left Canal.

The Project under sanction envisages the construction of a masonry dam near Nandikonda village, 290 ft. high (spillway) above foundation level upto F.R.L. + 520, with 5 ft. falling shutters and two canals, 135 miles and 108 miles long on the right and left side of the river, to irrigate 20·6 lakh acres. including 1.5 lakh acres of first crop and 1.5 lakh acres of second crop under the Krishna delta. The dam will be of the masonry gravity type, 4710 ft. and will be flanked by composite and earthen bunds of 35 ft. height. In the centre of the river will be located the masonry spillway, 1880 ft. long at F.R.L. + 520, with 5ft. falling shutters for discharging the floods. The non-spillway and power dam blocks will be raised to an elevation of + 560. On the left side, in the non-overflow section, the dam is provided with 8 penstocks of 14 ft. diameter to enable generation of firm and secondary power totalling to 300,000 kW. Of this, firm power at 60 per cent load factor will be 167,000 kW. Two penstock openings of 25 ft. diameter are also left on the right flank non-overflow section at the head of the right bank irrigation canal, to enable installation of two units of 30,000 kW. each, to generate another block of seasonal power of 60,000 k.W. The detailed design features of the dam are being worked out in consultation with the C.W. & P.C.

The Dam

The dam involves 185.24 M.Cft. of concrete and masonry. The work itself is a straight one and the site is one of the most favourable ones that are met with. The basic problem is not so much one of design or construction as of organisation, to develop and handle economically and speedily the huge quantities of materials involved and exercise adequate quality control over construction. To this end, the construction programme has been phased over three periods. In the first 3 years, the dam will be constructed to a level of R.L. + 300 to + 350, in the bulkhead and + 260 to + 270 in the spillway section. This will involve about 61 M.Cft. or about one third of the work. In the second period commencing from the 4th year to the sixth, the dam level will be raised to + 520. The amount of masonry and concrete involved will be another 124 M.Cft. in this period. The work in this period will have to be done by using the trestle bridge. In the final year, *viz.* the 7th, the dam will be completed to its designed level.

The reservoir formed by the dam under construction will be well contained within the gorge and will spread over 73.7 sq. miles. The storage capacity of the re-

servoir at F.R.L. will be 5.44 M.A.ft., with a live storage of 1.5 M.A.ft. The cost of the dam, including the cost of penstocks for the hydro-electric scheme, is estimated to be Rs. 33.84 crores.

The daily out-turn and requirements of materials to achieve the construction targets are as follows :

Average out-turn :

Masonry	800 units.
Concrete	200 units.

Peak out-turn :

Masonry	1,200 units.
Concrete	200 units.

Cement (bulk requirements per day)		400 tons.
Stone (bulk requirements per day)	0.88 lakh Cft. or	4000 tons.
Aggregate for concrete per day	0.20 lakh Cft. or	1,000 tons.
Sand —do—	0.40 lakh Cft. or	2,100 tons.
Surkhi —do—		100 tons.

Man-power requirement per day, (peak)

Skilled	3,500
Unskilled	30,000

Right Canal

The Right Canal takes off from the right flank of Nagarjunasagar dam and runs in detour open-cut till it meets the Pasuvemula range of hills at M.2/1. This range of hills will be crossed by a set of twin tunnels 1¼ miles long. Emerging out of the tunnels, the canal again runs in full cutting upto mile 4/4, then enters the plains and runs for a length of about 135 miles upto river Musi crossing. The canal is mostly aligned at the highest level possible at the toe of the Eastern Ghats and its outliers. It will irrigate 9.7 lakh acres including 2 lakh acres in the Pulichintala block. It is estimated to cost Rs. 29.33 crores Important details of the Right Canal are as follows :—

Sill level of off-take	+490.00
Discharge	11,000 cusecs. (unlined).
Bed width	177ft.
Depth of flow	15.7 ft.
Velocity	3.37 ft. per sec. (unlined).

The excavation of the canal upto mile 135/0 involves of 1,800 million cubic ft. of earthwork, including rock (an equal quantity being involved in the branches and distributaries), a single tunnel of 27 ft. diameter involving 8,085,000 cft. of rock removal and 1,500,000 cft. of lining, construction of major cross drainage works such as Chandravanka at M. 11/0, Nagileru aqueduct at M.35/0, Kandaleru aqueduct at M. 88/0, Gundlakamma crossing at M.100/0 apart from several other cross drainage works, bridges etc.

The construction programme has been phased over a period of 8 years, the 3rd, 4th and 5th years being the peak years of construction. To achieve the construction targets, a daily strength of 40,000 unskilled labour and 4,000 skilled labour will be required.

It is also proposed to employ earthmoving machinery where the workspots are remote, or leads and lifts involved are of such magnitude that human labour cannot be employed. Under this category will come works like Buggavagu earth dam, Gundlakamma earth dam and deep cuts. Machinery is also proposed to be employed where 20 per cent savings can be effected in time and cost. The best combination of earth-moving machinery such as scraper-pusher combination, loader-dumper combination of requisite numbers are programmed to be employed.

The average daily out-turn and total requirements of materials to achieve the construction targets are as follows :—

Earthwork excavation in all soils, excepting hard rock requiring blasting.	1700 units of 1000 Cft. each per day.
Earthwork excavation in hard rock requiring blasting.	125 units of 1000 Cft. each per day
Total requirements of cement.	1,60,000 tons.
Total requirements of steel.	15,000 tons.

Programme of Works

Detailed investigation of the main canal, investigation of branches and contour survey of the ayacut area are expected to be completed in 1957-58. Work on excavation in the Main Canal which was started in 1956 will be continued to the following programme :

1957-58.	Mile	0	to Mile	32	90,750	units.
1958-59.	,,	32	to ,,	52	3,25,000	,,
1959-60.	,,	52	to ,,	82	3,75,000	,,
1960-61.	,,	82	to ,,	102	2,75,000	,,
1961-62.	,,	102	to ,,	122	2,03,571	,,
1962-63.	,,	122	to ,,	135	1,95,453	,,
1963-64.	..	..		..	1,35,000	,,

Land acquisition for the Main Canal, involving 13,809 acres and branches and distributaries involving 30,920 acres will also be completed according to a phased programme.

The work on the tunnels will be taken up during 1957-58 and will be completed by the end of 1962-63.

The Left Canal

The Left Canal takes off from a head sluice located in an approach cut to the tunnel of 32 ft. diameter and of 10,100 ft. length. In continuation of this, there is a long open-cut extending upto M. 6/0 of the canal. After emerging out of these deep cuts, the canal crosses the Halia river at M.10/0 and Musi river at M. 44/0. The country up to the Halia river is the most difficult in the entire length of the canal. At. M. 80/0, it debouches into and takes off from the existing Palair lake. At M.105/0, the canal crosses the Munneru river by a dam. The canal is to be excavated for a length of 108 miles and will serve 6.7 lakh acres under 1st crop and 1.2 lakh acres under 2nd crop, in Nalgonda, Khamman, and Krishna districts. The canal is estimated to cost Rs. 23.4 crores.

The following are some of the important details of Left Canal :—

Sill level of off-take.	+490.00
Discharge.	11,000 cusecs.
Bed width (normal reach)	95 ft.
Depth of flow.	18.5 ft.
Velocity, (lined section)	4.8 ft. per second.
Velocity, (unlined section)	3.46 ft. per second.

The Left Canal upto Musi, i.e. upto M. 40/0 will be perennial and is, therefore, proposed to be lined. The lining will be done partially in this reach. The canal beyond is to be unlined.

The excavation of the canal upto M.108/0 involves earthwork excavation of 1,332 million Cft., including rock, a single tunnel of 32 ft, diameter involving 10.5 million Cft. of tunnelling and 2.3 million Cft. of tunnel lining, construction of major cross drainage works such as Halia, Nidamanoor, Devalapalli, Musi aqueduct etc., in addition to several other minor cross drainage works, bridges etc.

The construction programme has been phased over a period of 8 years, the 3rd, 4th, 5th and 6th years being the peak years of construction. To achieve the construction targets, an agerage daily strength of 30,000 unskilled labourers and 2,500 skilled labourers will be required.

It is also proposed to employ earth-moving machines in embankment portions where leads and lifts involved are such that human labour cannot manage.

The average daily out-turn and total requirements of materials to achieve the construction targets are as follows :—

Earthwork.	1340 units per day.
Excavation in hard rock requiring blasting.	150 units per day.
Total requirements of cement.	102,000 tons.
Total requirements of steel	12,000 tons.

Though the Right and Left Canals are being excavated to carry 11,000 cusecs each, the cross drainage works and bridges are proposed to be constructed for accommodating the full discharge for future development, as agreed to by the Planning Commission at the meeting held on 25th March. 1957.

Programme of Work

The construction programme of the Left Canal is so phased that preliminary and detailed investigation will be completed by March, 1958, the investigation of distributaries by March, 1961 and the block-levelling of the ayacut area by March 1959. Construction work on the Main Canal which has been started during 1956 will be speeded up and completed by the end of 1963-64 as per the following programme :—

1957-58.	Mile	6/0 to	Mile	20/0	60,000 units.
1958-59.	,,	20/0 to	Mile	32/0	2,09,000 ,,
1959-60.	,,	32/0 to	,,	50/0	2,67,700 ,,
1960-61.	,,	50/0 to	,,	68/0	2,72,000 ,,
1961-62.	,,	68/0 to	,,	89/0	3,09,000 ,,
1962-63.	,,	89/0 to	,,	108/0	2,00,000 ,,
1963-64.	..	..		..	48,278 ,,

Land acquisition for the Main Canal and branches and distributaries will be according to the above phased programme of canal construction and will cover 3,376 acres in 1957-58, 4,500 acres in 1958-59, 4,000 acres in 1959-60 and 2,000 acres in 1960-61.

Economics of the Project

The Nagarjunasagar Project provides for the irrigation of 9.7 lakh acres under the Right Canal, 7.9 lakh acres under the Left Canal and 3.0 lakh acres under the Krishna delta, making a total of 20.6 lakh acres at an estimated cost of Rs. 86.33 crores. The financial return at the end of 10 years after the completion of the project, or 17th year after starting of work, comes to 2.64 per cent. The financial yield on invested capital is, however a particularly unsatisfactory guide to investment decisions in under-developed economies, as there is apt to be considerable divergence in such economies between private and social returns. From the social point of view, a project which utilises unemployed man-power and saves on scarce resources like foreign exchange, steel etc. is to be preferred to a project which is capital and foreign exchange intensive. From this point of view, the social cost of the Nagarjunasagar Project must be reckoned to be low, as it makes considerable use of manual labour and is economical in the use of such scarce resources as foreign exchange, steel, etc.

So far as the product is concerned, apart from the output of 800,000 tons of foodgrains, the other normal chain reactions wil unfortunately not fully materialise as the Hydro-electric part has not been included in the Project—indeed, even the quantum of direct output in respect of agricultural commodities will be affected if the outlay is restricted to the figure of Rs. 86.33 crores. With an extra outlay of Rs. 36 crores for full development, an additional area of 12 lakh acres can be brought under irrigation, the cost per acre coming to Rs. 300 in this case, as against Rs. 430 for the restricted scheme. It will, therefore, be fair to say that the low figure of return on the Project is due largely to the artificially assumed stoppage of the Project at a certain level and consequently the proportionately higher expenditure on the Dam and the Canals as compared to the benefits. Further, as already pointed out, the hydro-electric scheme is not a part of the Project at this stage and hence no credit has been taken for the revenue from power generation : even so, an investment of roughly Rs. 75 lakhs has had to be provided in the estimates for the construction of penstocks in the Dam, which from the technical point of view cannot be postponed. On this investment, there will be no return at this stage. With only an additional expenditure of Rs. 9 to Rs. 10 crores, it will be possible to generate firm and secondary power totalling 300,000 k.W. in addition to another block of seasonal power of 60,000 k.W. Thus, under full development, will increased irrigation and power generation, the percentage return will be substantially increased

Apart from direct returns, other substantial revenues will accrue from the construction of a Project of this magnitude, such as increase in tax revenue.

(This article is based on the Report of the Project for its first year 1956-57.)

Facts at a glance

Nagarjunasagar Project

Particulars	*Project as envisaged by by Andhra & Hyderabad Govts. in their joint Reports.*	*Project under approval by the Govt. of India.*
1. Location	1½ miles downstream of Nandikonda village, Andhra Pradesh, across Krishna River, 110 miles upstream of Vijayawada anicut.	
2. State Covered.	Andhra Pradesh.	
3. Date of Inaugration by the Prime Minister of India	10th December, 1955.	
4. Date of commencement of work	February, 1956	
5. Target date of completion.	1966	1963-64
6. DAM		
(*a*) Masonry Dam :	3900 ft.	3900 ft.
(*i*) Spillway.	1880 ft.	1880 ft.
(*ii*) Non-overflow, inc : of Power Dam.	2020 ft.	2020 ft.
(*iii*) Average ht. above foundation level.	367 ft.	302 ft.
(*b*) Composite Dam : length	4960 ft.	4960 ft.
(*c*) Earth Dam : Length	6220 ft.	3800 ft.
Height	67 ft.	35 ft.
Width at top (Non-overflow Dam).	27 ft.	27 ft.
Width at base.	287 ft.	287 ft.
Top of dam above sea level.	+597.00	+560.00
(*d*) Gates	Yes	No
Total excavation :		
(*a*) in Rock	24.20 M.Cft.	24.20 M.Cft.
(*b*) in Earth	7.20 M.Cft.	10.40 M.C.
Total quantity of masonry in Dam.	172.90 M.Cft.	173.40 M.Cft.
Total quantity of concrete in Dam.	....	11.84 M.Cft.
Total quantity of Earth in Dam (embankment)	53.50 M.Cft.	52.40 M.Cft.
7. COFFER DAM		
(*a*) Length	....	3,000 ft.
(*b*) Height	....	40 ft.
8. RESERVOIR		
Gross Storage Capacity	9.30 M.A.ft.	5.44 M.A.ft.
Live Storage Capacity	5.39 M.A.ft.	1.50 M.A.ft.
Reservoir Water-spread	110 sq. mils.	73.66 sq. mils
Number of village to be submerged	30	18
Population to be displaced	....	13,227
9. COST OF THE DAM	Rs. 34.72 crores	Rs. 33.84 crores.

(contd.)

Particular	Right Canal		Left Canal	
	Project as envisaged by Andhra & Hyderabad Govts. Joint Report	*Project under approval by the Govt. of India*	*Project as envisaged by Andhra & Hyderabad Govts. Joint Report*	*Project under approval by the Govt. of India*
10. CANALS				
Length	276 Miles	135 Miles	140 Miles	108 Miles.
Discharge	21,000 cusecs	11,000 cusecs*	11000 cusecs	11000 cusecs.*
Quantity of Earthwork excavation in main canal.	2930 M.Cft.	1675 M.Cft.	1536 M.Cft.	1339 M.Cft.
Quantity of Rock excavation in main canal.	288 M.Cft.	125 M.Cft.	170 M.Cft.	149 M.Cft.
Quantity of earthwork in embankent in main canal.	818 M.Cft.	766 M.Cft.	975 M.Cft.	925 M.Cft.
Masonry Works				
(*a*) Regulators	14	6	L.S.	L.S.
(*b*) Falls & Weirs	3	3	L.S.	L.S.
(*c*) Aqueducts	12	4	9	8
(*d*) Under-tunnels	166	67	67	74
(*e*) Railway Bridges	2	2	..	..
(*f*) "A" class Road Bridges	18	11	9	8
(*g*) "L" class Road Bridges	31	17		
(*h*) Foot Bridges	35	12	..	..
(*i*) Cart Bridges	..	..	38	27
(*j*) Escapes	8	4	2	5
11. Command	39.5 Lakh Ac.	22.6 lakh Ac.	12.8 lakh Ac.	..
12. Ayacut—Canals	18.58 Lakh Ac.	7.9 lakh Ac.	10.0 lakh Ac.	7.9 lakh Ac.
13. Ayacut—Krishna Delta		3.00 lakh Ac.		
14. COST OF THE CANALS.	Rs. 61.09 crores	Rs. 29.33 crores	Rs. 26.20 crores	Rs. 23.40. crores.

*Cross masonry and other works are designed for ultimate capacity.

Continued from page 4

Kosi Project

(*viii*) *Construction Materials for Barrage and Headwork*

(Requirements sources and methods of Transpcrt).

Sl. No.	*Materials*	*Sources*	*Distances of quarry from site*	*Total quantity required*	*Method of transport proposed*
1	2	3	4	5	6
1.	Coarse aggregate (Natural gravel deposit)	Sardu Khola near near Dharan	35 miles	115.22 lakh cft.	By Project N.G. Railway.
2.	Filter (do)	—do—	32 „	58.16 lakh cft.	—do—
3.	Rock fill (do)	—do—	—do—	1998 lakh cft.	—do—
4.	Riprap (sand stone rock)	Chatra	—do—	153.69 lakh cft.	—do—
5.	Sand	Gengajali Dhar	16 miles	54.77 lakh cft.	Project Tram tra-track 2 ft. gauge.
6.	Cement	Factories in South Bihar.	350 miles	72,000 tons	Mainly by Eastern and North Eastern Railways.
7.	Steel	Calcutta	300 miles	8,755 tons	—do—
8.	Earth	Borrow areas	upto 4 miles	2,800 lack c.ft.	Manually where lead is small and mechanically in case of long leads.

Continued from page 12

Full Utilisation of India's Water Resources

Economy by Better Agriculture

Engineering techniques and technical management undoubtedly play an important part in the economic utilisation of irrigation supplies. But the agricultural aspect of the problem is equally important. Exhaustive soil surveys of areas covered under any project, along with field analysis of representative soil samples, study of land topography, analysis of temperature graphs, and rainfall statistics are required for fixing crop patterns. It is only after such a study that assessment can be made of broad irrigation requirements for purposes of planning and control of irrigation systems. In this field there are many known and unknown factors. Study of meteorological data and climatological factors, therefore, plays an important part in proper crop planning and irrigation. Water requirements of different crops can be determined experimentally under different natural conditions. Quantity of water to be fed into different irrigation systems, basing such requirements on proper crop-planning could then be judged more accurately. Excessive application of water, which proves harmful to the crops, apart from causing wastage, could thus be avoided.

The time table of water supply also plays an important part. Levelling up of the fields as accurately as possible, even of the rice fields, also goes a long way in causing an even distribution of water and therefore a saving in the overall application of the quantity of water. In advanced farming practice, levelling and contour-bunding is the first step taken towards preparation of the field.

Education of the Farmer

All these new techniques cannot be applied overnight in India for want of suitable equipment and materials. But there is also a lack of progressive outlook on the part of our cultivators. A planned education programme based on demonstration and field instructions will go a long way in preparing the people for adopting new techniques. Instead of concentrating activities on a few selected State farms it may be better to help operations on private farms in selected localities under conditions settled between State agencies and farmers. That may help the drive for improvement in irrigation and agricultural techniques gaining adequate momentum.

The cultivator at present considers the supplies as belonging to the State. The feeling of partnership in the project and the ownership in the assets of the undertaking is generally lacking. A healthy water conservation consciousness will arise in the minds of the users only when they are alive to the moral responsibility with regard to proper and economic use of water for irrigation. Their moral fibre is to be toned up so as to create in them a sense of cooperative responsibility for enforcing water-users, etiquette as different from punitive rates which tend to increase corruption. The problem is, therefore, not only irrigational or agronomic, but is also socio-economic. (Courtesy : "Bhagirath")

Full Utilisation of India's Water Resources

By BALESHWAR NATH

India is building a number of minor, medium and major irrigation schemes under the Five Year Plans and expanding irrigation systems aimed at fuller utilisation of our water resources. The increase in irrigation facilities is not however compatible with the rate of rise in population. More and more production is consequently sought for from the available resources of land and water. It is therefore imperative that our irrigational practices and agricultural operations are revised, so as to be conducive to optimum utilisation of the available resources. Efforts are required to be made, both in the field of technical management and of agronomic operations as well as towards conservation of resources through reduction of wastage, wherever possible.

Conveyance Losses

Considerable amount of irrigation supplies get lost by way of conveyance losses in the channels, that is through deep percolation or wasted run-off. An assessment made in a major irrigation system like the Ganga Canal in Uttar Pradesh indicated that, of the total supplies diverted in the canal, 15 per cent are lost in the main canal, 7 per cent in distributaries and 22 percent in village watercourses.

For us in India the problem is multi-faced. It involves improvements in engineering techniques of storage, diversion, conveyance and distribution of water, in technical management of irrigation supphis, in agronomic operations and crop planning and in the administrative and revenue setup of irrigational organisations. In short, comprehensive utilisation plans have to be evolved for optimum utilisation of available irrigation resources.

Weir-Controlled Canals

In weir-controlled canals, the flow varies with fluctuation in the river. In times of keen demand, canal supplies cannot be raised, as there is no storage and the river flow may not be adequate to meet the demand. On the other hand during rainy seasons, there is extra water in the rivers, which rolls away to the sea. There is also the problem of silt, which gets into off-take channels and chokes the distributaries and minors. A broad assessment made in the Punjab indicates that the diversion system as adopted in weir-controlled canals, leads to waste to an extent of about 30 percent of the annual run-off of the river. Experts, therefore, suggest that in the interest of fuller utilisation of our resources, wherever possible, canals should be fed from storage reservoirs and not directly from diversion weirs. Where effective conversion is possible from weirs to storage schemes, wholly or partly, it would seem advantageous to implement them preferably in consonance with flood protective measures.

With a view to increasing the efficiency of canals, particularly those taking off from diversion weirs, it has been suggested that tanks should be planned along the canals, as much as possible which could be filled during the rainy season and used later. The ideal location of such tanks would be in the head reaches of channels. A major project of this type is nearing completion in Uttar Pradesh, where Sarda Sagar has been located on the tail race of the Sarda Hydro-electric Power Station to hold the supplies that escape through the power house during the rainy season. These supplies can be utilised to serve large areas in winter cropping. To implement the scheme effectively, the Sarda Canal system is being remodelled accordingly.

Conservation by Lining

Losses in irrigation systems themselves are also considerable. In unlined channels they are of the order of about 8 cusec per million sq. ft. of wetted area. If the channels are lined the losses come down to about 2 cusec per million sq ft. With thousands of miles of channels spread all over the country, considerable economy can be effected if water-courses are properly lined wherever feasible. There are various materials utilised for lining purposes. Cement concrete, brick masonry, soil cement, clay puddle bitumin and plastic sheets have been used with advantage, according to the availability of material in different localities. In new projects lining is an economic proposition, because greater velocities of water can be adopted in lined channels, and to pass the same discharge smaller canal sections need to be built. There is corresponding saving in the recurring maintenance cost. Benefits derived by lining the village

The Tungabhadra Lined Canal: Lining of canals considerably reduces seepage losses of irrigation water.

channels with a waterproof material, as a measure against seepage loss are quite spectacular. In the case of some tubewell channels in Bihar, an annual loss of Rs 1,305 per tubewell in revenue due to seepage was turned by bituminous lining into a net profit of Rs. 158, after allowing for the cost of lining, interest on capital outlay and maintenance charges. Considerable work and experimental research is being done in this direction in India as well as abroad.

Village Watercourses

Besides the State-managed irrigation channels like the main canals, distributaries and minors, there is the far greater mileage of village watercourses, which actually convey water to the fields. Unfortunately, almost in all the State-managed canal systems in India, there is complete withdrawal of State management at this stage.

The village watercourses are generally ill-shaped, poorly maintained and follow zig-zag patterns of alignment. Their realignment, renovation and improvement will therefore go a long way in avoiding wastage which takes place through evaporation and percolation in the winding, sluggish village watercourses.

Reuse of the wash-out in certain crops like paddy, and in such areas where percolation is fast, is another way of putting water to greater use. There are two ways of doing this. One way is to have two canals, one below the other instead of one contour canal. The discharge of single canal could be distributed between the upper and lower reaches in the ratio of 50 : 40 or 60 : 30, dictated by the needs of the localities. The lower canal gets the benefit of water and seepage of the upper one. An economy of about 10 percent is thereby effected. This system is applicable only in short lengths of canals and in sloping areas. The other method is that each distributary block may have one canal on either side of it into which waste and seepage water will be flowing down. This waste water can be diverted to contour channels in irrigated tracts and made use of by lands lying below them. Contour channel has to be aligned to intercept 15 to 20 percent of the distributary block. The main branch canal may then be designed to carry 85 to 80 percent of required discharge. Numerous other ways of economising water and of conserving the resources can be devised.

Evaporation Losses

In storage reservoirs there is considerable loss through evaporation. Cumulatively this adds up to a big proportion of stored supplies. In countries like Australia, where water scarcity is normal, vast experiments are under way to minimise the losses through evaporation. Methods under investigation in Australia are being subjected to tests at a few sites in India. There are many disturbing natural forces which hinder such experimentation. Persistent efforts may, however, yield beneficial results. It may be possible to develop some indigenous material, which when applied to reservoir surfaces would minimise the evaporation losses. This is required to be done only during periods of low humidity, i.e., dry season. Most of the evaporation losses occur in that period. If the loss is effectively controlled, water so saved could be utilised very profitably for irrigation of crops from small reservoirs. In so far as its application to large reservoirs is concerned, the question is still very problematic.

Economy in Tubewells

The exploitation of underground resources has been done considerably in U.P., Punjab and Bihar. Between these three States, there are over 10,000 tubewells in operation in the Indo-Gangetic plain. When farmers used water for irrigation from tubewells, it is generally paid for quantitatively and is, therefore, naturally used most frugally by the peasant. Tubewells therefore, make a perfect system for economic utilisation of water. Though our sub-soil resources are apparently plentiful and there is likely to be no adverse effects on account of this pumping, at least in the foreseeable future, yet it will be prudent to be cautious.

Tubewells are operated invariably by electric power. This makes it possible to improve the economy of tubewells by adopting the more modern technique of spray irrigation instead of surface irrigation. By this method, water piped from the source is sprayed like rainfall over the crops evenly and in requisite quantities. It has been found that water application by this method is not only profitable to the crop but conducive to great economy in the use of water.

Other Methods

Besides spray irrigation, there are many other watersaving devices used in countries like the U.S.A., in actual irrigation. In place of open watercourses, piped water lines, generally in concrete, are laid out. These can be joined up with mobile pipe rolls in rubber or plastic and distribution of water is caused in the fields directly without incurring any transit seepage or evaporation. In certain areas, sub-surface irrigation is done with the help of perforated pipes laid below root-zones of the plants. This system keeps the root-zones supplied with the necessary moisture, without involving losses otherwise incurred in surface application of irrigation water.

A system of drainage either by tiles laid underground or otherwise is also employed in areas where ground conditions warrant it. The surplus water is recovered and reused, thus saving the land from water-logging. Even where water is conveyed through open channels, cuts need not be made in the channels or smaller watercourses to feed different sectors of the plot. Instead small siphon pieces can be used with advantage yielding greater efficiency in distribution and application of water.

Continued on page 10

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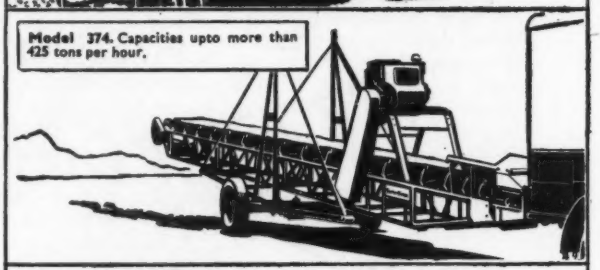

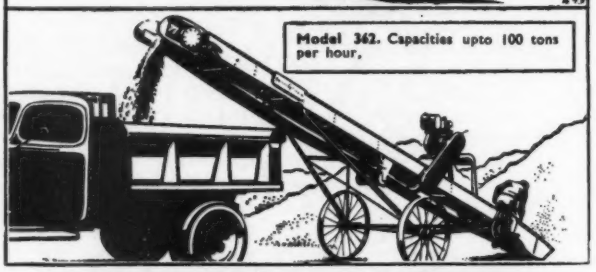

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No. 1048 P.O.

Stornorrfors Hydro-Electric Power Station and its Turbines

Making use of the accumulated head from a number of rapids in the lower reaches of the Ume River, situated in Northern Sweden, it has been possible for the Swedish State Power Board to obtain a total head of approximately 75 metres which will be utilized to produce power in the Stornorrfors Power Plant now under construction. This plant will replace some older stations that previously utilized part of the rapids, and its tail water level will be at sea level.

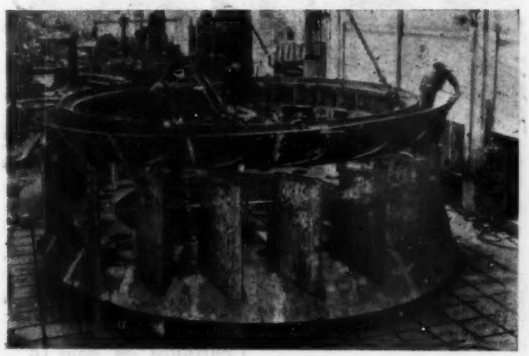
The ultimate discharge through the station will be 800 m^3/ sec. In the first stage, however, only three units will be installed, each designed for a discharge of 200 m^3/sec. corresponding to a guaranteed output of 178,120 H.P at a net head of 73 metres and a speed of 125 rpm. An output of 200,000 H.P. is guaranteed at 75 metres net head, thus making the turbines the largest in the world with regard to output.

In accordance with later years' practice in Sweden, this plant will be of the cavern type, entirely blasted into the solid rock. The water will be led to the turbines through vertical penstocks, one for each unit, lined with steel plate and with concrete grouted in between the steel plate and the surrounding rock. At the head of the penstocks are installed sectorgates or so called tainter gates with the operation mechanism designed for quick closure and provided with other special devices made necessary by the absence of shut off valves at the spiral inlets. The water from the turbines is discharged through a 4-km long tail race tunnel, in common for the whole station, having a cross section area 390 m^2 and thus believed to hold the world record for this type of tunnel.

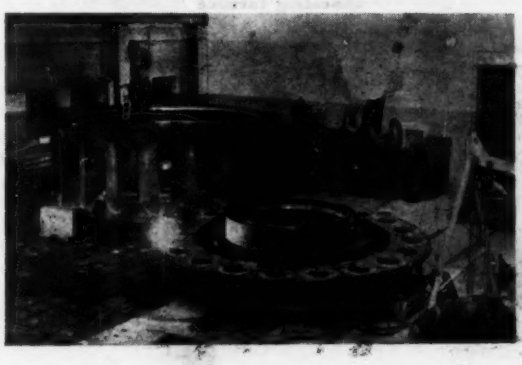
The large output per unit naturally calls for turbines with very large dimensions, as the design head is only 75 metres. It is only due to the fact that the plant is situated on the coast, making possible sea transport, that splitting the runners in two could be avoided, if this at all had been possible at the head in question. In any case the splitting of the runners would have been a very complicated and costly solution. The turbines have been ordered from Nydqvist & Holm Aktiebolag (NOHAB), and will be manufactured in their Trollhattan works situated on the Gota River, making possible direct shipment by boat from their works. The question of transport naturally also arose when a subcontractor for the runner castings was to be chosen and therefore only foundries having access to quaysides could be considered.

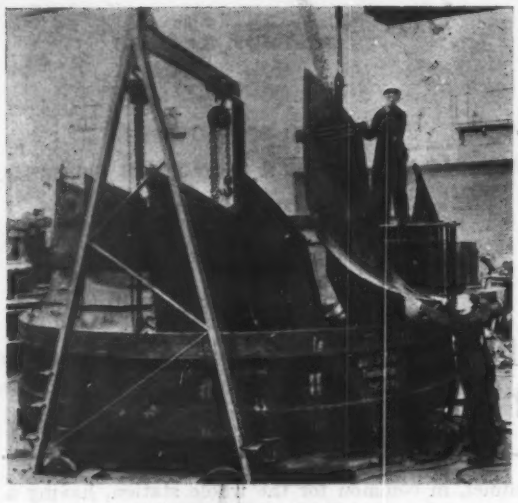
The runners will be made entirely of stainless steel and, although it was possible to have them cast in one piece, in spite of the fact that their finished machined weight is 67 tons, NOHAB decided to cast the hub, and buckets separately and weld them together. The main reason for this procedure is that greater accuracy is attained on the blade angles and openings at the same time as it is possible to grind and polish the buckets to a very fine surface finish

Assembling a stay ring

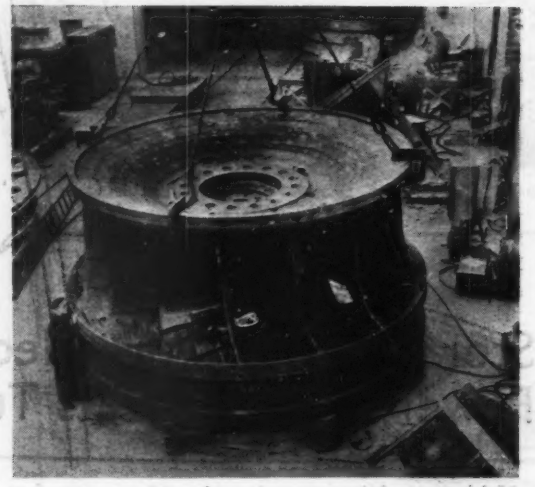


Stay ring and head cover being assembled





Assembling the buckets.



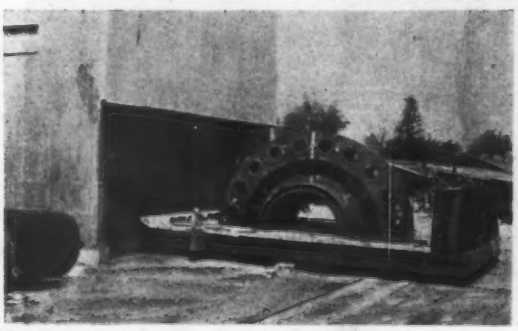
A runner partly assembled.

and also machine the water passage surfaces of the hub and band. In connection with this it can be mentioned that a maximum efficiency of 93.5% has been guaranteed.

As the purchaser only approved of martensitic cast steel, a great many problems in connection with the welding had to be solved. NOHAB have therefore co-operated with foundry and welding specialist in developing and adopting a welding procedure involving various stages of welding and heat treating processes that will guarantee a perfectly sound and reliable runner. The problems have been solved and the runners are now being manufactured according to the method developed. It has already been possible for another Swedish turbine manufacturer to make use of this method, developed at Nydqvist & Holm Aktiebolag when manufacturing smaller runners than those for Stornorrfors.

Other large turbine parts, such as stay rings made according to NOHAB's patented design, head covers etc. are fabricated from steel plate and welded instead of having them made from cast steel or cast iron. This assures an homogeneous material. At the same time it makes possible a more light weight design. NOHAB are well equipped for welding and have specialized on this type of work for many years.

A head cover before annealing in the new annealing furnace

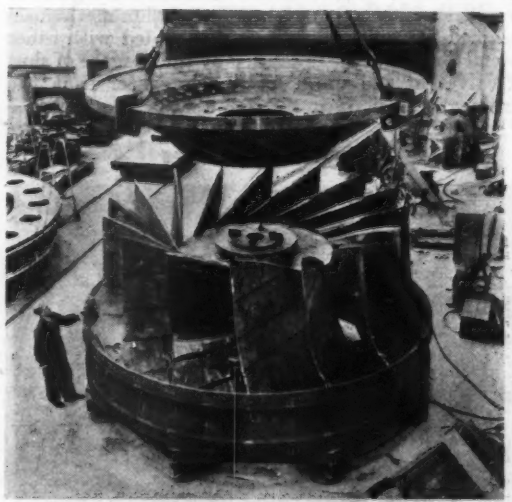


Recently Northern Europe's largest annealing furnace was installed, making it possible to stress relieve even the largest turbine parts. The spiral casing welds are X-ray examined.

In other respects the turbines will be of conventional design. The main guide bearings will be of NOHAB's self-lubricating type, an extremely simple design developed by them, which has proved to give a very reliable service.

In accordance with normal practice on large units like these, the governors will be divided up into three separate groups i.e. servomotors with distributing valves, oil pressure units and actuators. The servomotors will be placed directly on the head covers, thus binding all the acting forces within the turbine, and eliminating all the disadvantages encountered when having the servomotors placed in the concrete structure. The actuators will be of the

A step in the fabrication of the runner



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A "TVA" for South East Asia

The arrival in Bangkok, Thailand, of a UN Technical Assistance Mission, headed by Lt. General Raymond Wheeler of the Suez Canal Clearance fame, marks a new milestone in the progress of a mighty plan which promises to make the lives of some 17 million people in a corner of South East Asia, fuller and more human. The Wheeler team, comprising of some world renowned engineers and hydraulic experts, will be undertaking a three-month survey of possible project sites along the lower Mekong River Basin for the ultimate development of one of Asia's largest rivers to benefit the bordering population of four countries—Cambodia, Laos, Thailand and Vietnam.

The Mekong is one of the largest rivers in the world. It rises high up in the snowy mountains of Tibet and after a run of some 2600 miles through four countries it empties into the sea. The total drainage area of the Mekong River basin of some 795,000 square kilometers equals about the size of Burma. Seventyfive per cent of this drainage area is in the lower Mekong River basin and equals in size of Afghanistan. Some 17 million people live in this area, and their lives are closely affected by its seasonal whims and vagaries. While like other big rivers, it is the lifestream for the people who live on the territory around it, it has been compared, like most other big rivers, to an 'idle but a destructive giant'. Flowing through mountain canyons, high up in the snowy tops of Tibet, it wanders on its way through many countries, through forests and through barren wastes. In its uncontrolled violence of floods, the Mekong every now and again menaces the land and the people that surround its course. Like all other great rivers, it has its erratic ways and its periods of idleness and sulks; a wandering inconstant river, its waters are wasted and inundate several million acres of valuable rich land every year.

The United Nations Economic Commission for Asia and the Far East (ECAFE) has been collecting information about the Mekong since 1951. Activities had to be discontinued during the Civil War in Indo-China, but were resumed shortly afterwards and considerably stepped up in 1956 when a team of ECAFE consultants and experts, joined by officials from the riparian countries, reconnoitred the lower river basin. This group of experts travelled through the area by plane, boat, car and on foot. In the end they produced a valuable report which has outlined the key problems and possibilities of the Mekong. The immediate task of the Wheeler team, which includes top-ranking experts like Kanwar Sain, Chairman of Indian Water and Power Commission, Georges Duval, Director of a hydraulic laboratory in France, Yatuka Kubota of Japan and John W. McCammon of Quebec Hydraulic Commission, will be to review existing studies and to examine some of the specific projects recommended in the ECAFE report. The development potentialities of the Mekong are considered enormous. Its potential wealth has hardly been tapped. For instance, less than three per cent of the area under cultivation in the four riparian countries—Cambodia, Laos, Thailand and Vietnam—is irrigated. Experts estimate that by building storage barrages that would allow utilization of the present net run-off of the Mekong, irrigation facilities could be provided for an area of some 23 million acres, which is considerably more than the total area now under cultivation.

Besides extending the arable land, irrigation projects could save and improve rice crops and help develop other crops such as maize, cotton, tobacco, soyabeans and peanuts, thereby bringing diversification in agriculture to countries which for centuries have depended too much on the production of one crop rice. Prospects for the production of hydroelectric power are considerable and it is estimated that the Basin could provide more than four million kilowatts of firm energy per year. Development of inland navigation is another part of the scheme and in course of years the river through its major course in the basin may become totally navigable.

The work that now lies ahead of the Wheeler mission is only one of the preparatory steps for the creation of a "TVA" of the South East Asia. United Nations field investigations and studies, as previously stated, were started by ECAFE's Bureau of Flood Control in 1951, and the importance of this work—development of the Mekong as an international river—was reaffirmed at ECAFE's annual session in 1955. Subsequently the four riparian countries met in May 1957 and, after a discussion of the ECAFE report agreement was reached on the need for cooperative action. A Committee for Coordination of investigations of the Lower Mekong Basin was established by the four countries. It held its first session in Phnom-Penh, capital of Cambodia, on October 31 this year. Highest priority was given by the Committee for Coordination to three projects, originally recommended by ECAFE, and these are the three projects to be specifically examined by the UN expert mission now in Bangkok.

The expert team, headed by 72-years old retired engineer of the American army and a consultant to the International Bank for Reconstruction and Development, is already busy in consultations with the representatives of the four riparian countries directly concerned. It is programmed to carry out aerial inspection of the Mekong from its mouth to its delta, and visit several of the project sites by car, boat and helicopter. The General who recently came into international limelight by clearing the Suez in record time, hopes to be able to begin drafting his report in another month or five weeks' time.

Basically, the United Nations investigations would concentrate on projects that (1) would be parts of a coordinated pattern for the whole of the Lower Mekong Basin ; (2) would benefit more than one country ; and (3) would be integrated in multi-purpose projects—that is, they would wherever possible provide for simultaneous all-round development of the river basin, mainly through irrigation, flood control, hydroelectric power and navigation. The plan envisages the harnessing of an 'idle and destructive giant', which will free many millions from the drudgery and chronic want, and bring them a new life. The three specific projects which will receive top priority are the *PA MONG*, *SAMBOR* and the *TONLE SAP*. The first of these, the Pa Mong project involves construction of a dam with a head of 22 meters at a site about 30 kilometers above Vientine, the capital of Laos. Some 2000 million cubic meters of water would be stored. Half of the discharge from the stored water would be used to irrigate the dry areas of the northern Thailand and the other half aid navigation by raising the water level in the river during the dry period. From it, some 120,000 kilowatts of firm power would be generated and about half a million acres of land irrigated.

The Sambor project, as envisaged by ECAFE, would take advantage of the existing rapids. A dam would be constructed and hydro-electric power amounting to a quarter of million kilowatts generated. This would later be increased to 360,000 kilowatts. Irrigation would be provided for some quarter million acres of land and a ship lock would be provided for navigational purposes.

The Tonle Sap project will include a barrage on the Tonle Sap, which connects the Mekong with the Great Lake and would moderate the flow of water between the two. The flood peaks of the Mekong would thus be cut off during the highwater period while controlled supplies of water could be released during the dry season for irrigation and for navigational purposes.

All these three projects are so conceived that they would benefit more than one country; and the river basin would be developed as part of a multipurpose scheme that would coordinate overall plan of requirements for irrigation, flood control, hydroelectric power and navigation etc. Additional benefits resulting from the development of the Lower Mekong River would come from the development of mining and timber resources and from accelerated industrialization.

In its scope and potentialities, the whole project has been likened to the Tennessee Valley (TVA) project in the United States. Like the TVA, when completed, it is expected to bring about considerable economic changes in this part of South East Asia and contribute greatly to an improvement in living standards of the local population. The Mekong Project, when completed, will be another stirring story of man's fight against and victory over want, made possible by the United Nations programmes for Technical Assistance.

Here, in an unknown and underdeveloped part of South East Asia, in another few years, the boundless energy of a sleepy but erratic giant will be working for people living in that area. In this, which is one of the thousands of such valleys of the earth, the physical setting of men's living will improve. The destructive river will become productive, the land more secure and fruitful, forests and mother earth will yield their rich treasures and new factories, workshops and houses will put a different face upon the entire landscape. More than all this, it will be a new experiment in international living and international cooperation and coordination.

Flowing through as many as four different countries—Cambodia, Laos, Thailand, Vietnam—the Mekong river will become more than ever the River of Destiny for the millions of people living on its two banks, irrespective of their political differences. It may become a common tie, binding different peoples in one common bond. The river has a unity which has already brought the experts from these four riparian countries together. Ventures like the Mekong project symbolize the spirit of the United Nations Technical Assistance Programmes, the spirit that is rich with international character....and may some day become the final arbiter in international affairs. Peoples of other backward and under-developed parts of the world, in Asia and Africa, will be watching with keen interest the progress of the Mekong project, which promises to bring new life to these ancient lands.

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Stornorrfors Hydro-Electric Power Station and its Turbines

NOHAB-ASEA type, i.e. electro-hydraulic. These actuators are exteremely sensitive and their main advantage as compared with the conventional mechanical-hydraulic type, is their versatility with regard to controlling the turbines by various quantities, for instance, not only frequency and load as previously but also by water level, waterflow, line power, synchronous time etc. Electro-hydraulic actuators are therefore in Sweden more and more replacing the conventional mechanical-hydraulic type. In this connection it can also be mentioned that the first electro-hydraulic actuators for large turbines were developed in cooperation between ASEA and NOHAB, although they are now manufactured by other firms as well. The three different oil pressure units will be interconnected to assure uninterrupted operation.

The plant will be equipped with modern instruments of various types as well as a great number of safety devices, so that the attending personnel can be reduced to a minimum.

The power station with three units installed is expected to be completed during 1959, but the first unit will be taken into service already during the autumn of 1958.

Flood Control in West Bengal

The following statement has been issued by the Government of West Bengal in December last on the flood problem in the State.

The State of West Bengal extends from the high hills of the Himalayas to the Bay of Bengal. Innumerable rivers, big and small, traverse this State from different directions, through all the districts. Thus, the whole of West Bengal is vulnerable to floods. Some of the big rivers come from hilly places beyond the borders of West Bengal and even of India. So, it is difficult, sometimes impossible for this State to tackle with these rivers. In such cases floods come on without warning and create havoc.

For dealing with her flood problems, West Bengal may broadly be divided into three zones—

(1) North Bengal, comprising the districts of Darjeeling, Jalpaiguri, Cooch Behar, West Dinajpur and Malda.

(2) South Bengal, covering the southern parts of the 24-Parganas and the Midnapur districts.

(3) The rest of this State may be included in the zone of Central Bengal.

After the devastating floods in Bihar, West Bengal and some other States in 1954 the Central Government in the Ministry of Irrigation and Power appointed in the same year a Central Flood Control Board with the Minister of Irrigation and Power, as the Chairman. The Irrigation Minister of West Bengal is on the Board. Subsequently four River Commissions with experts were appointed for the flood-affected regions of India. They are the Ganga River Commission, the Brahmapurta River Commission, the North West Rivers Commission, and the Central India Rivers Commission. West Bengal is concerned with the first two commissions; the Special Engineer for Flood Control (West Bengal) who is a retired Chief Engineer of the Irrigation and Waterways Department is a member of each of the two Commissions. All the four Commissions have been reconstituted on the November 26, 1957.

The Union and the West Bengal Governments are quite conscious of the seriousness of the flood problems of this State and have appointed several Committees and Boards to enquire into the causes of floods and water-logging, to suggest remedies and to work them out to the extent of available funds, materials and personnel. Further, the problems are so vast and varied, covering almost all the districts of West Bengal, that it is better to tackle them zone-wise as the Government are doing.

North Bengal Zone

Let us come to the North Bengal zone. The rivers descend rapidly upon the plains of the terrai from the Himalayan heights. The gradient is very steep and the rainfall is heavy. As a consequence huge volumes of water come down with a tremendous velocity, often carrying with them big trees and huge boulders as also shingles, sand and silt. Sometimes, a tree or two stick in between protruding stones, other trees and boulders accumulate behind them and an artificial dam is erected on the course of the river. Water behind the dam rises and forms into a lake. Formation of several such lakes on the course of the same river is not rare. When the rainfall is normal or even less and when the engineers and the inhabitants of the plains are least expecting any floods, a lake or lakes might burst and a roaring flood might come down with a high head, fretting and foaming, upon the unsuspecting and unprepared people below. Such was the case with the 1952 flood of the Teesta in Jalpaiguri. Sometimes a barrier thus created just below the foot of the hills would not burst, but the accumulating water would take a side course and the whole river would flow with a tremendous velocity down this new alignment, over protected forests, cultivated lands, tea-gardens, villages and bazars. Sand several feet deep, would be deposited on the land making it unfit for cultivation for years to come. Such was the case with several rivers of North Bengal during the last decade. Cases of erosion of lands, even of towns like Cooch Behar, are not rare. Whenever there is severe flood in some of the rivers of North Bengal, the National Highway and the Railway are breached at places and even bridges are damaged or washed away. Unscientific felling of trees for years in the forests on the hills in West Bengal, Sikkim and Bhutan, as also the "jhooming" system of cultivation and indiscriminate grazing have laid bare vast areas to torrential rains, which cause innumerable landslides and soil erosion on a very big scale. The detritus carried down by the floods is deposited on the bed of the river in the plains where the velocity decreases to a great extent. The cross-section of the bed shrinks and the capacity to hold water diminishes. Thus, a smaller flood than that of any previous year might cause a greater inundation of the banks. Even small tributaries would, sometimes, cause more havoc than the main river.

Such being the extensiveness and enormity of the flood problems of North Bengal, no single and simple solution can be found out even for a selected river. An extensive and intensive survey must be thoroughly made, for years together, over the vast catchment areas of the rivers, which extend beyond the borders of West Bengal and of India, into Nepal, Sikkim and Bhutan. Some information may have to be got even from Tibet. Most of the areas are inaccessible. Long and protracted correspondence and even conferences had to be undertaken by the External Affairs Ministry of the Government of India to get permission to enter the territories and set up some observation centres. So far, seven rain gauge stations, one rain-*cum*-river-gauge centre, and six rain-*cum*-river-gauge with wireless centres and two river-gauge-*cum*-wireless stations have been established in Bhutan by the West Bengal Government. Our men are working there. Bhutanese are being trained to take charge of these centres in future. Within North Bengal, seven hydrological stations for river-gauge reading and twenty-four river-gauge-reading-*cum*-silt observation stations have been set up so far. Far from human habitation, our reconnaissance teams and survey parties have worked and are working cheerfully and with the zeal of national workers, even in the deep forests infested with wild and ferocious animals. They have to go to places where no conveyance, not even an elephant or a pony can carry them. There are no roads, nor even hill tracks. A reconnaissance team had to climb up to an altitude of 17,000 feet from sea level and walk a long distance over snow. Three reconnaissance teams have completed their survey of the Teesta Valley, the Rangit Valley and the catchment areas of the rivers the Lissh, the Gish, the Chel, the Neora and the Relli. Our Survey parties have completed survey of selected sections of the river the Mechi, the Balason, the Mahananda, the Teesta, the Lissh, the Gish, the Chel, the Neora, the Dharala, the Jaldhaka and the Kaljam ; work of the Torsa and the Raidak II are continuing. They have taken, so far, 385 cross sections. The Survey Department of the Government of India has made aerial survey of a large part of North Bengal and the progress up to September 1957 is (1) 2-inch aerial photography of 3,849 square miles, (2) 2-inch semi-control photo mosaic of 5,705 square miles, (3) field levelling (secondary lines) of 632 square miles, (4) field levelling (tertiary network) of 2,195 square miles, and (5) spot heighting of 65 square miles.

It has already been stated that deforestation, "jhooming cultivation" and indiscriminate grazing cause landslides and soil erosion on a huge scale. Before big dams are planned, afforestation, terraced cultivation and controlled grazing may have to be introduced in the mountains of India, as well as of Sikkim and Bhutan. Other soil-conservation works, such as construction of small check-dams and anti-erosion works have also to be taken up at places.

From the above statements, it will be evident why the Government have not been able to formulate any long term measures for North Bengal. Further data must be collected before launching upon a big project costing crores of rupees. A hasty step on presumptious or incomplete data might aggravate a problem, instead of solving it. Supposing that a very high dam is built on the bed of a big river which carries enormous quantities of detritus. The reservoir will be filled up in a few years and might create new problems, besides huge wastage of money.

Again, partition of Bengal has made the solution of the problems of North Bengal all the more difficult. A high dam on a big river, which may work for 50 years or more, is generally utilised for three main purposes, namely, (1) flood control, (2) irrigation, and (3) generation of hydel power. After partition, there is a very narrow strip of plain land between the foot of the hills and the border line of Pakistan. Even this terrain is undulated. Enough culturable land will not be available for utilising all the impounded water of the dam. In this thinly populated area, for several years to come, there may not be enough customers for the consumption of the energy likely to be generated. Practically, the whole money is to be spent for the sole object of flood-control This may not be a sound economic proposition in these hard financial days. Even then, all such considerations may not rule out the construction of such a dam altogether. Careful consideration must be made of the likely loss to the people and to the Government due to floods, the amount of money the Government may have to spend for various relief measure, and on development works, and above all, the amount of human suffering and misery which can never be calculated in naye payse. The Government are, therefore, proceeding cautiously but steadily towards solution of this vexed problem. In recent years the Irrigation department have created for the North Bengal district the posts of one Superintending Engineer, four Executive Engineers and sufficient number of subordinate officers, besides the survey parties and reconnaissance teams already mentioned. The Irrigation, the Forest, the Agriculture, the Roads Development and the Works and Buildings Departments of this State, as also the Irrigation and Power, the Railways and the Survey Departments of the Government of India are working in close co-ordination for satisfactory solution of this problem of floods.

In the meantime the State Government completed, 19 short term schemes estimated to cost Rs. 2,34,47,000; three more schemes with a total estimate of Rs. 20,98,000 are almost complete. Mention may be made of the flood protection and anti-erosion works in the towns of Jalpaiguri (Rs. 66.40 lakh), Siliguri (Rs. 9.06 lakh), Alipurduars (Rs. 18.74 lakh), Cooch Behar (Rs 61.25 lakh), Mathabhanga (Rs. 15.18 lakh), Toofangung (Rs. 9.88 lakh) and English Bazar (Rs. 1.16 lakh). For all such works in the urban as well as in the rural areas of North Bengal, the expenditure up to the end of 1956-57 was Rs. 224.30 lakh and the anticipated expenditure for 1957-58 is Rs. 75.00 lakh. Six other flood control schemes in West Dinajpur district and seven more in Malda district are now under preparation while some other schemes in other districts of North Bengal are under investigation.

South Bengal Zone

Let us now come to the South Bengal Zone. Here flood problems arise from the estuarine rivers and the sea. Although both the Midnapore and the 24-Parganas districts have been included in this Zone, let us concentrate on the Sundarbans. Centuries back, the Ganga used to flow down the Bhagirathi, but for some natural causes she changed her course and is now flowing down the Padma in East Pakistan. Before

she lost her identity in the sea, the Ganga split up into innumerable big and small channels, thus forming the deltaic estuary, of which a great part constitutes the Sundarbans. The Sundarbans of undivided Bengal was the biggest estuarine forest in the world. West Bengal has got only that portion of it which lies in the 24-Parganas. This delta is peculiar to West Bengal, the like of which cannot be found anywhere else in India. The Ganga used to bring down heavy quantities of silt from uplands and throw them into the sea near the mouth. The heavier silt was deposited and it ultimately formed small islands which gradually raised their heads above the low-water level. Grass would grow on these islands and finally a thick forest would cover them. This process of delta-formation went on for centuries. After the Ganga changed her course, this process gradually slowed down and practically stopped long ago, although the rivers in the southern districts still carry down a comparatively smaller amount of silt. Two flow and two ebb tides pass up and down the estuarine rivers every day alternately. The flow tide carries with it a good amount of suspended silt. When the river water spills over low lands, most of the suspended silt is deposited there. The velocity of the river during ebb-tide is much slower, hence a good quantity of the silt carried by the flood-tide remains deposited on the bed of the river itself. This process goes on twice every day. Previously, the Ganga used to bring huge amount of upland waters with a huge velocity. They scoured down to the sea the silt on the beds of the rivers deposited during ebb-tides. After the Ganga changed her course, this scouring process gradually slowed down and has practically stopped while the silting of the beds is going on as ever. Thus, the condition of the estuarine rivers is rapidly deteriorating. Some of the smaller rivers have already died and others are dying, leaving long stretches of water-logged areas and lagoons. Almost all the islands of of the Sundarbans used to be submerged by flow-tides, specially by spring-tides (higher flow-tides). Silt would settle down, gradually raising the land. For pressure of population and scramble for land, the British Government took the very unwise and unscientific step of reclaiming these forest-lands for cultivation and habitation. For this purpose the islands were leased out to Lotdars. The terms and lengths of the leased periods differed at different times. No food crops can grow in saline water ; nor can men and cattle live on lands twice inundated in a day. Therefore, the fittest thing the lotdars did was to shut out the saline water from the low lying fields by putting an earthen Bund round the land. Then the trees were cut down and the land made fit for cultivation. About half of the area of the Sundarbans has thus been prematurely reclaimed under this process. Thus half of the spill-area of the flow-tide has been curtailed. As a result, the silt, which might have been deposited on these islands are being deposited on the beds of the rivers, hastening their deterioration and final death.

The first impulse would be to give back the reclaimed areas to the sea as before. But a thickly populated State like West Bengal with a steady inflow of refugees cannot afford to lose 1,460 square miles of reclaimed land, where about 11.5 lakhs of people live and about 6.4 lakh acres of land are under cultivation, growing, in normal years, better yield of foodgrain on an average than other parts of the southern districts. Thus, the two baffling and contradictory questions face each other ; whether to save the prematurely reclaimed lands and knowingly allow the rivers to rapidly deteriorate or to lose the fertile lands to the sea for forest formation and the raising of the land surface. Adopting any of the two courses is to commit an offence against future generations. The experts are racking their brains to find out a satisfactory solution. This may require long and numerous model experiments in the River Research Institutes. In the meantime, the reclaimed lands are to be protected by maintaining and strengthening the embankments. Here, again, a new problem has arisen. As the bed of a river rises the highest level of flow-tide also rises ; and so, the heights of the embankments are to be raised higher and higher. Thus, an unwholesome competition goes on between man and nature, where ultimately, nature wins. A time comes when the bed of the river becomes higher than the level of the protected lands within the embankments by the side of the river. The fields remain water-logged due to accumulation of rain water and may gradually become unfit for cultivation and also for habitation. Such a state may not come in a year or even in a decade; it may take even a century or a half, but it is bound to come some day unless some way out is found. Otherwise, very costly schemes of pumping like that at Uttarbhag (Sonarpur) have to be adopted.

The total area of the Sundarbans is 3,089 square miles, of which 1,460 square miles have been reclaimed for human settlement. Within this area, 1,000 square miles are under cultivation and 190 square miles are under fisheries. The total length of the embankments is 2,194 miles. The Lotdars used to maintain these embankments, but when they came to know of the proposed abolition of Zemindaries, most of them neglected the embankments. Moreover as the rate of payment for earth work went up very high, even normal repairs went beyond the means of some Lotdars, specially of those who had leased out all their lands at a rental of Rs. 6 to 9 per acre without keeping much land in khas possession. The condition of the embankments worsened so much that the Government had to spend a sum of Rs. 1.02 crore on behalf of the Lotdars, between 1st January, 1954 and 14th April, 1955 (before vesting of the Lotdari rights on the Government). When the State Government took charge of the embankments after the vesting, they had to face two difficulties : (1) finance, and (2) accommodation for the engineering staff and offices.

The Irrigation and Waterways Department of West Bengal included in its Second Five-Year Plan a proposal to spend Rs. 3.5 crore for the maintenance and remodelling of the embankments for constructions of sluices for proper drainage of the cultivated lands. When the Development Department was asked to formulate the Second Plan, the total estimate of expenditure of all development heads ran up to 600 crore of rupees. The final figures had to be brought down to Rs. 153 crore which did not include Rs. 3.5 crore for the Sundarbans. Thus almost all the Departments had to curtail their programme. Due to this fact, it became impossible for the Irrigation Department and difficult for the State Government to find out an extra amount of Rs. 3.5 crores outside the Plan provision. After some months of discussions and correspondence with the Centre, the State Government somehow provided necessary funds for main-

tanance of the embankments in the Sundarbans. Obviously, some time lapsed before the money could be found. The Irrigation Department spent Rs. 38 lakh in 1955-56, Rs. 53.17 lakh in 1956-57 and provided Rs. 30 lakh for the current year. The Land Revenue Department also made a provision of Rs. 15 lakh for this year. Besides, the Relief Department spent good amounts every year much of which was spent for embankments. In 1954-55, the Central Government granted a sum of Rs. 1 crore for various relief measures, incuding works by the Irrigation Department, to be undertaken in the Sundarbans only.

The second difficulty was about placing the officers. Considering the peculiar problems of the Sundarbans, the Collector of 24-Parganas has been specially invested with powers of an Executive Engineer of the Irrigation Department. No other D.M. or D.C. has got this power. There are two Additional Executive Engineers under him. There are nine Subdivisional Officers (Irrigation) and 41 Sectional Officers under the Executive Engineers. Special watchmen and labourers on a monthly pay, called Beldars, were also appointed. Their number varied from time to time. At a time it rose to about 1,000. It has already been stated that the Sunderbans are mainly a big cluster of small islands, each surrounded by water on all sides. The reclaimed islands are protected by marginal embankments, which together run to a length of 2,194 miles. The islands are approachable only by water. During high winds and during the rainy season, they are not easily accessible by boats also. So, the best course to take was to post Sectional Officers and Irrigation S.D.O.s at suitable places near the embankments in the Sunderbans. But no suitable houses were procurable, nor could they be constructed in a short time, as materials are not easily available there, apart from the questions of heavy expenditure. Therefore, in spite of honest efforts, there could not be proper supervision to the satisfaction of the Department. In some cases the Government had to spend a large sum for the protection or repair of some portions of an embankment, where a prompt action by a local officer on the spot would have required a much smaller amount; nor could wastage be checked properly. At last it has been decided that the petty repairs and overall supervision of the embankments will be entrusted to the Land and Land Revenue Department which has a good number of Tahsildars all over the Sundarbans. They can take prompt action and keep a good supervision. The Irrigation Department will do the more difficult and costly works which require technical skill. This is the arrangement which has been in force since 1st December, 1957. To add to our difficulties, a severe cyclone passed over Sunderbans, causing innumerable breaches and damages to the embankments in 1956. The same year in September, the highest tidal bore in fifteen years dashed against the whole length of the embankments and inflicted 445 breaches within two days. Fortunately our officer could close 412 of them within a week, before the next bore came after a fortnight, others were repaired soon. Surely this was no mean achievement in those inaccessible areas in the rainy season. In 1957-58, there were 108 breaches, of which all but one were closed right away: At the time of acquisition of the Estates (Lotdaries), there were 205 masonry sluices and 36 box sluices. Since then we have constructed 239 box sluices and our programme for the current year (1957-58) is (*a*) to thoroughly repair 70 existing masonry sluices and to construct 60 such new ones; (*b*) to construct pucca protective works of over 5 miles of the embankments; and (*c*) to construct 30 miles of retired embankments and to strengthen 40 miles more. Moverover, 100 miles of creeks are to be closed. About 200 miles of embankment are going to be planted with trees.

Central Zone

Let us now come to the Third Zone. This area lies on both sides of the river Bhagirathi-Hooghly. On her east, the Jalanghi and the Churni pour their water into the Bhagirathi. All the three are practically cut off from the Ganga due to heavy silting at their starting points. During the rainy season they get water from the Ganga for a few days only. For want of upland floods and freshets from the Ganga, these rivers are gradually silting up. The only remedy is to divert sufficient quantity of water from the Ganga. For this, the Ganga Barrage Scheme is under consideration of the Central Government. Some of the rivers in the east like Jamuna, the Bidyadhari and the Peali are already dead, leaving vast water-logged patches. Mention has already been made of the Greater Calcutta Master Plan. Out of the schemes given first priority, two are already completed, two others are almost completed and one is under consideration for inclusion in the Second Five-Year Plan. The Schemes are as follows:

(1) The Sonarpur-Arapanch-Matla Drainage Scheme—Part I (completed). The estimated cost is Rs. 55.30 lakh and the benefited area is 23,350 acres. Having failed to find out an ordinary flow channel for drainage, a pumping project which was then the biggest of its kind in Asia, had to be undertaken. Four pumps with a total capacity of pumping out one thousand cubic feet of water per second was installed;

(2) Sonarpur-Arapanch-Matla Drainage Scheme—Part II (almost completed). The estimated cost is Rs. 71 lakh, benefiting an area of 23,040 acres. Some trouble has arisen about the Dabu sluice and the Engineers are investigating for a solution;

(3) Bagjola-Ghuni-Jatragachi Drainage Scheme (almost completed). The estimate is for Rs. 104.0 lakhs with an area of 25,600 acres to be benefited;

(4) Ichapore Basin Drainage Scheme (completed). The estimated cost is Rs. 1.64 lakh and the benefited area is 1,710 acres; and

(5) Tollygunge-Panchannagram Drainage Scheme (to be included in the Second Plan). The estimate is for Rs. 29.25 lakh and the area to be benefited is 2,496 acres of agricultural and 5,596 acres of non-agricultural land.

On the west of the Bhagirathi-Hooghly, some rivers fall into her, coming down from the hills of Bihar. The main rivers are the Mayurakshi, the Ajoy, the Damodar, the Dwarakeswar, the Silabati and the Kansabati. The Subarnarekha touches only a fringe of this State and falls directly into the Bay of Bengal; even then she sometimes inundates parts of four thanas of the Midnapur district. Let us take up these rivers one after the other:

(1) The Mayurakshi and her sister rivers— the Bakreswar, the Brahmani, the Kopai and the Dwarka.

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British Electricity Act, 1957

In view of the fact that power development in India is taking place at a rapid pace and is likely to continue to do so, it is of great interest and usefulness to study the organisational pattern of the electricity supply industry in Great Britain, particularly since its nationalization in 1947. Only very recently the Electricity Act was enacted as law after a great deal of enquiry and debate in the country as well as in the Parliament. The Electricity Bill arose out of their report to the Committee of Inquiry into the Electricity Supply industry under the chairmanship of Sir Edwin Herbert which was appointed in July 1954. Its report was ready in 18 months. Within a year of the publication of the report a bill was presented to the Parliament and within another 8 months the bill became law. The importance of the Act lies in the fact that it incorporates nearly 10 years of the experience of nationalization of this crucial industry. From this point of view it is of essential importance that we in this country study not only the present Act but also its material variation from the original Bill as well as from the Herbert Committee Report. Of course it is important to keep in mind the context of the legislation namely the highly industrialised background of the country, with the further development of atomic energy as an important source of power in the immediate future.

The following paragraphs reproduced from a contribution of Mr. D. J. Poolton in the Electrical Review of July, 1957 are devoted to a general outline of the Electricity Act in its final shape, side by side indicating the major changes that have been incorporated in the various stages of its evolution. The implication of the various provisions of the Act are also analysed in terms of the actual operational and financial terms.

* * * * *

Generation and Supervision

The major change effected by the new Act, and one which is central to both the Herbert Committee's recommendations and the Government's purpose in promoting the measure, is the separation of the functions of generation and overall supervision which are at present both exercised by the Central Authority. A new body, the Central Electricity Generating Board, will have responsibility only for generation and main transmission in England and Wales, with a special responsibility for the expanded nuclear power programme. The supervisory and controlling powers now exercised by the Central Authority over the whole field of electricity supply (including distribution) will devolve in part on a newly created body, the Electricity Council; in part on the Area Boards; and in part disappear from the industry entirely and in effect will accrue to the Minister of Power.

The net result will be that the Area Boards will have somewhat more power and greater autonomy but the industry as a whole will no longer have a "head" capable of speaking and acting for it with authority, and of exercising any general control over its policy and operations.

Generating Board

The Generating Board will consist of a chariman and seven to nine members appointed by the Minister, and it will take over the generating functions of the present Central Authority together with all its property, rights and liabilities except those (not pertaining to generation) which vest in the Electricity Council. No subdivisions of the Generating Board are specified, and it must be presumed that the existing Divisional structure will be maintained for the time being.

Electricity Council

The second body set up by the new Act is the Electricity Council. Its functions are to be *advisory and permissive rather than compulsive*, and it is intended to act as a forum whereon leaders from the two sides of the industry—generation and distribution can discuss their common problems and concert their joint and separate activities. It will not be an executive authority and its character will be more that of a cabinet or the board of directors of a large holding company. The Council's main duties are to advise the Minister on questions affecting the industry, and to promote and assist the Electricity Boards in maintaining and developing an efficient, co-ordinated and economical system of supply.

Although the Council is not directly responsible for co-ordinating the industry's activities as a whole, it has a *special responsibility* for scrutinising and advising on the Boards' capital investment programmes. The Council also has power, when so authorised by the Boards, to carry out *common services* on behalf of the

industry. These are likely to include research, the raising of capital, the maintenance of joint machinery regarding employment, and related staff problems such as safety, welfare and training.

With these functions in view it is not surprising that the composition of the Council is largely made up from the personnel of the Boards themselves. In the Bill as first introduced it consisted very simply of the chairmen of the twelve Area Boards, two members from the Generating Boards and one to three outside members appointed by the Minister, one of whom would be the Council's chairman. This composition was vigorously debated during the Committee stage of the Bill, and the Act provides for up to six members (including the chairman and two deputy chairmen) to be appointed by the minister from persons who are not members of an Electricity Board. These will be additional to the fifteen ex-officio members (three members from the Generating Board and the twelve chairmen of the Area Boards) making twenty-one in all which might be considered somewhat on the big side.

Broadly speaking, it would appear that electricity organisation in England and Wales has now come much nearer to the gas pattern, with a central Council assisting but not controlling a number of independent regional corporations. The two situations are, however, so different that there is no reason why the same solution is best for both. The Gas Council has a relatively easy task because it has no nation-wide production machine to deal with, whereas the electricity industry can never lose sight of the fact that public generation in this island is technically one system and can never again be chopped up into separate pieces. In fact, *whilst political and legislative change in recent years seems to have shown a centrifugal tendency, technical developments such as atomic generation, pumped storage and higher-voltage transmission, all tend to increase the economy of operating as a single unit* from the south of England to the north of Scotland.

Autonomy and Economics

The Herbert Committee laid great stress on the importance of the commercial criterion both as measure of efficiency and as a spur to greater efforts. Each element in the industry should, it was felt, approximate as nearly as possible to *a self-contained trading organisation and should endeavour to "make a profit" or its nearest equivalent within the context of nationalised operation.* This principle was accepted by the Government, and the Act probably goes as far as is feasible in carrying it out. Instead of the industry as a whole having to balance its accounts, each separate Board (that is to say the one Generating Board and the twelve Area Boards) is now charged with the duty of seeing that its revenues are not less than sufficient to meet its outgoings taking one year with another.

The implication of this is that whilst there has to be prior consultation with the Electricity Council before tariffs are fixed, the individual Boards will be more closely (because financially) responsible for fixing the prices of what they supply. This is equally true of the Generating Board which must fix the price of its bulk supplies so as to show a profit (or avoid a loss) on its operations. And therein lies the rub.

One difficulty in legislating for the electricity industry is that the technical and the commercial divisions do not coincide. Technically there is a clearly marked division into the two functions of generation and distribution, and the administrative machinery follows the same cleavage both in past legislation and still more in the latest Act. But when it comes to making each side of the industry into a commercial concern one meets the insuperable difficulty that all the money made by the industry is on the distribution side. It is only the Area Boards which receive money from the public for services sold competitively in the open market, whereas the Generating Board (which actually consumes about 70 per cent of the money) merely sells its products within the industry itself and not to the public. Until there is some objective way of evaluating this product and finding its market price *there is no possibility of running either side of the industry by itself as a commercial concern.*

Inter-Board economics are a little like the large see-saw which can sometimes be seen in a children's playground, with several small boys at each end and a somewhat older person standing in the middle with one foot on each side. In this case there is one big boy —the Generating Board—at one end of the plank, and twelve smaller boys—the Area Boards—at the other, whilst the person in the centre is the Electricity Council. The plank itself represents the bulk supply tariff and the aim of each of the bodies on the ends is to maintain a balance. There may be scope for a certain amount of mutual shuffling between the Area Boards at their end through changes in the proportions of the tariff but the main factor will be changes in the total magnitude. This will bring one end up, and the question is whether the person in the middle will have sufficient horse-power to make the whole machine work at its best.

The fixing of the bulk supply tariff is therefore the crux of the matter when it comes to operating the Boards as separate commercial concerns. It would be perfectly easy for the Generating Board to show a handsome profit merely by slightly increasing this tariff, and the Area Boards could all show profits if the tariff were reduced. It could, of course, be fixed so that each side of the industry made the same percentage margin of profit or loss, but this would make nonsense of the clear intention of the Act, which is to make all the Boards individually responsible for paying their way.

Financial Provisions

The Act does not go so far in the direction of financial independence as the Herbert Committee recommended. Instead of the Boards being allowed to float loans in the open market the Electricity Council is empowered to issue British Electricity Stock which the Treasury may guarantee up to a maximum indebtedness under all heads of £1,400 million. The Council then allocates the stock as between the Generating Board, the Area Boards and the Council itself, and the ultimate responsibility for meeting the obligations in respect of this stock will rest with these bodies according to this allocation.

Each Board and the Council is required to make its annual report direct to the Minister and *no provision appears to have been made for a consolidated report.* Among minor changes, the Area Boards are to have limited powers to generate electricity for themselves in

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Notes & News

Irrigation Schemes for Maharashtra

A deputation of the Deccan Agriculturists' Association, led by Shri D. R. Gadgil, waited on the Chief Minister recently to put forward their point of view on matters connected with the development of irrigation in Maharashtra.

The deputation emphasized the importance of major irrigation schemes in the rural economy of West Maharashtra wherein large tracts are chronically liable to periodic scarcities and famines. It was emphasized that the backward and unstable economy of these parts will not be improved unless, by means of the execution of major irrigation schemes, the agricultural activity of the region could be made more diversified and secure. Government agreed with this point of view. It was pointed out on behalf of the Government that it was in pursuance of these objectives that quite substantial provisions had been made in the second Five-Year Plan of Bombay State for execution of major irrigation schemes in West Maharashtra. Four such schemes viz. the Vir, Khadakwasla, Mula and Girna projects, had been included in the works to be carried out during the Second Plan period, apart from the Konya project.

The deputation expressed concern over the apprehension entertained in some quarters that delays were being caused in construction of projects due to their constant revision. It was explained to the deputation how in giving final shape to a project, revisions of some technical details are frequently found necessary. These had to be considered and improvements carried out when the need for them, from the point of view of technical requirements of the project or more economical methods of achieving desired objectives made it necessary to do so. The deputation expressed a general view that conditions in the Deccan were more favourable for the construction of masonry dams than earthen dams. It was explained on behalf of the Government that the final choice of the type of dam was a matter to be considered on a comparative study of various alternatives from the technical and economic point of view. An important aspect relevant in this connection, especially at the present moment, is the limitation of foreign exchange, which would be required for earth-moving machinery in the case of large earthen dams.

The deputation suggested that the Kukadi project in the Bhima valley should be taken up in preference to the Sirur project. It was explained to the deputation, on behalf of Government, that *prima facie* the Kukadi project would not seem to give any advantage over the Sirur project especially as the latter would give large storage and consequently greater potential for irrigation. It was further explained to them that during the Second Five-Year Plan period a systematic study of the water resources of river valleys is going to be taken up to prepare plans for optimum utilisation of water, and that both Kukadi and Sirur projects will be reviewed along with others during these investigations. A Water Resources Investigation Circle has already been created for the purpose.

The deputation expressed anxiety over the reported delay in the construction of the Khadakvasla and Girna projects. The deputation was informed that this fear was unfounded and that Government in fact hoped that both these projects as well as the Vir dam project would be carried to a stage by the end of the Second Plan period at which actual benefits would begin to be realised.

The deputation made a reference to the proposal of constructing two earthen dams in the upper catchment of Khadakwasla instead of a new masonry dam immediately below the existing dam, and urged that the original proposal of constructing the masonry dam be pursued. It was explained to them that the proposal of constructing two earthen dams was preferable as it would make a saving of a crore of rupees in the overall cost. Again, it will make development in stages possible, enabling early realisation of benefits and will leave further scope for development by construction of a dam on the main Mutha river whenever such need arises in future. In the case of the old proposal of constructing a masonry dam, additional storage would have become available only after the construction of the dam had reached a height higher than the present dam and a large volume of masonry would have had to go in the construction till this height was reached.

With regard to the Mula project, it was explained to the deputation that there were certain technical difficulties relating to foundation for the dam and that more investigations were necessary before the dam design could be finalised This may entail some delay

in taking up the construction of the head works but the intervening time will be utilised for carrying out ancillary works and the distribution system until Government is in a position to take up the actual execution of the dam itself.

The deputation was informed that the Vir, Mula and Girna projects are at present under the consideration of Government for according administrative approval. As regards the Khadakwasla project, detailed investigations have been completed in respect of the proposed two earthen dams at Warasgaon and Panset. Preliminary works such as construction of approach roads, colonies, etc., are already in progress on all these four projects.

The deputation had urged in its memorandum that Government may consider the feasibility of low head electric power from the new storage projects to be constructed. Government informed them that the suggestion will be investigated for the different storage projects.

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The Use of New Sources of Energy

Within the last few years experts in energetics have become interested in the problem of getting electric energy by using solar heat. Solar heaters have for a long time been widely used in the southern districts of the USSR, where there is a great number of sunny days in the year. These devices are used for heating, boiling and distilling water, cooking food, drying fruit, vegetables, tobacco, cotton, tea, etc. Solar heat shower baths, bath-rooms, laundries, water boilers, and hothouses with ground heat accumulators, solar kitchens have also been designed.

Scientistis now work on the problem of designing refrigerating solar installations. The problem of air conditioning in houses, public buildings and industrial plants and constructing refrigerator warehouses for storing foodstuffs is a very important one for the southern districts.

Soviet scientists are also working on designs for helioenergetic plants. Preparations are now in progress for the construction of the first experimental industrial helioelectric station in the Soviet Union. Several years ago the Heliotechnique laboratory headed by V. Baum of the Krzhizhanovsky Power Institute under the USSR Academy of Sciences eleborated the project of such a station. TheArmenian designing institute is completing the station project. It is to be built in the Ararat valley near Lake Aigerlich, not far from Yerevan, the capital of Armenia. This site has been chosen for the station because it is one of the most sunny in the USSR ; according to meteorological data the average quantity of sunny hours in the year is 2,600, which makes it an average of 7 sunny hours per day.

The plot of ground allotted for the station is enormous, of circular form, about one kilometre in diameter. The plan provides for the construction of a tower 40 metres high in the centre of the site. It will be equipped with a huge revolving steam boiler. Twenty-three concentric circles of railway lines will encircle the tower. Twenty-three automatic trains carrying 1293 large reflecting mirrors mounted on an equal number of wagonettes, will run on these railways. Automatic devices, connected with photoelements, will make the mirrors follow the visible movement of the sun so that they will always be directed towards it. Other automatic devices will turn the boiler so that its "screen", that is, the side designed to absorb sun rays, is continually turned to the reflection of the sun. The energy of all the concentrated solar rays will heat the water and turn it into steam. An experimental model of the automatically controlled reflector has already been designed and is now undergoing tests.

The station is planned for a capacity of 1,200 kW. It must supply electric current to the adjoining inhabited communities. The station will also feed current to the pumps which will pump out subsoil waters and deliver them to fields and vineyards for irrigation. It is also proposed to supply heat in the form of steam or hot water to houses and industrial plants.

The solar electric station will be able to work in clear sunny weather only. In view of this the plan provides for means of joining it to the existing electric system, so that clients will not be deprived of electric current at night time, or on cloudy days, but will then get current from the general electric system.

Heat accumulators—large underground water reservoirs with thermal insulation, something in the nature of huge thermos flasks—are planned for the station with a view to providing clients with a constant supply of hot water. They will hold water heated by the sun to about 80°. All the hot water spent will gradually be replaced during the station's work on sunny days.

The Ararat valley heliostation is only the beginning of a new branch of energetics with great future prospects.

In the electric station which is to be built in Armenia electric current will be produced by the gradual transformation of energy : solar energy into heat, heat into mobile energy and mobile energy into electric energy.

But research is conducted with the object of finding methods of directly transforming radial solar energy into electric energy, without the intermediary stages of transformation. This must open still greater prospects for the development of energetics. A thermoelectrogenerator has been designed in the heliolaboratory of the Institute of Energetics of the USSR Academy of Sciences. It transforms the energy of solar rays into electric energy by means of plates soldered of two different metals. Research is also conducted in the use of photoelements or semi-conductors for the same purpose.

Geothermal energetics, or the use of heat from deep layers of the earth for electric stations, also has a great future, and so has the use of marine energy—the energy of sea tides. It is not impossible that new sources of energy, that can also be placed at man's service, will be discovered in the near future.

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Kariba First Stage Completed

James Morris, writing in the Manchester Guardian

described the completion on schedule of the first stage of the Kariba Dam with the breaking of the northern cofferdam. "The inescapable air of cheerfulness to the Kariba project is provided largely by the Italians, who seem pleasantly free of conventions and prejudices and whose multi-lingual injunctions to the workers ('a bulldozer is not an infuriated buffalo : drive it carefully') often have piquancy as well as point. Your Italian is as ready as the next European to swear at his African-labourer ; but in the rock tunnels of Kariba you may find an Italian handling the same drill as a Black man or driving tippers side by side with Africans—sights that would be inconceivable in for example the gold mines of the Rand or the Orange Free State. The heavy hand of trade unionism does not lie heavily upon Kariba, and the industrial colour bar, so important an issue on the Copperbelt or in the Union, seems to be distinctly shaky.

Among all this brave energy and vision not a trace remains of the Batonka, whose lands are to be flooded by the reservoir. They have all gone, with official encouragement and compensation, to start a new life elsewhere. They did not do so very willingly. But thanks to patient work by Government commissioners and a scale of compensation that seems on the face of it just, all the Kariba Batonkas have gone. Fairly soon all their compatriots on both sides of the river—some thirty thousand in all—will have moved too. Some of their witch doctors, it is said, were enlisted into the ranks of enlightenment and helped by occult means to persuade the tribesmen towards a peaceful move. But the Batonkas nevertheless have done their best to take their ancestral spirits with them by uprooting trees of special significance and transporting various other symbols of the divine presence. Nobody has had to be forcibly ejected : but the Batonka go on the understanding that if, as they suspect, the lake is never created at all they can come back to Kariba again—triumphant emissaries of conservatism proud flanters of that immemorial slogan 'I told you so'.

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Congo Power Plan

Plans are being considered to construct the biggest industrial centre in Africa, dwarfing anything of the kind in the Union, at the mouth of the Congo near Matadi. There is a vast hydro-electric potential in the Lower Congo at Inga. The first phase is being investigated from the industrial angle by aluminium interests in Belgium, the United States, Canada, Germany, Switzerland and Italy.

The manufacture of wood pulp from the equatorial forests, the separation of the fissionable isotope of uranium from ordinary uranium for nuclear energy and the production of nitrogen fertiliser from air are other industries demanding big supplies of cheap power. The Lower Congo, the second largest river in the world, falls more than 330 feet in 16 miles.

Belgian experts calculate that at least 25 million kilowatts could be generated there by the low-water flow of the Congo. This is equal to score of Karibas or eight times the total capacity of all the Union's power stations. The full potential would not be harnessed for thirty years or more. The Minister of Colonies, M. Buisseret, has asked a commission of international experts to study the reports of four different groups of consultants, including big American and Scandinavian concerns.

The cost of the first stage is likely to amount to £240 million. Half of this would be needed to construct factories, ports, roads, housing etc. to consume the initial production of 1½ million kilowatts.

Continued from page 20

Flood Control in West Bengal

A Reservior Scheme has been completed at an estimated cost of Rs. 15.85 crore. The Canada Dam at Messanjore has created an artificial lake of 27 square miles. Ultimately, six lakh acres of land will get Kharif irrigation and 1.20 lakh acres are expected to get Rabi irrigation. About 4,000 k.W. of Hydel power is also being generated. This project has its own arrangement for drainage.

(2) The Ajoy—Investigation is being carried out. A dam across this river may have to be constructed somewhere in Bihar.

(3) The Damodar—The Damodar Valley Corporation, a statutory body constituted by an Act of the Indian Parliament is tackling this river with her tributaries. The scheme has three main aspects, namely, flood control, irrigation and generation of power. Up to 1957-58 the actual and estimated expenditure for flood control will amount to Rs. 21.04 crore, of which this State has to contribute Rs. 14.04 crore. The DVC has also taken up drainage schemes in the area to be irrigated by it in West Bengal.

(4) and (5) The Darakeswar and the Silabati—No scheme is ready for these rivers. Investigation is going on. A scheme was prepared for the Tarajuli, but it could not be included in the Second Plan.

(6) The Kansabati—A scheme estimated to cost Rs. 25.5 crore is under operation. The Irrigation and Waterways Department wanted Rs. 20 crore for the Second Plan, but, only an amount of Rs. 4.75 crore has been allotted by the Planning Commission. The progress of work must, therefore, be slowed down to a great extent. This project, which is expected to irrigate about 8 lakh acres of land, has also some flood control aspects

Continued from page 22

ecial circumstances. Such powers would enable em to undertake combined power and heating hemes.

Power to Manufacture Equipment

One of the most hotly contested items in the debates on the Bill concerned the Generating Board's power to manufacture. Before nationalisation it was usual for an electricity company to be free to manufacture its own plant if need be. This freedom had obvious advantage on a small scale in respect of such things as spare parts or specialised equipment which might not be so quickly or cheaply obtainable from the regular manufacturers. On a large scale it could serve as a threat to counter price rings. In the 1947 Act the Central Authority had power to manufacture electrical plant and fittings whilst the Area Boards' powers in this respect were limited to the repair and maintenance of fittings. Under the latest Act the *Generating Board will not be allowed to manufacture plant unless it is satisfied that available facilities for obtaining such plant at reasonable prices are, or might become, inadequate.*

Consultative Councils

Two small changes have been made affecting the personnel and the functions of these Council. In the past, not less than half of the members had to be appointed from a panel nominated from members of local authorities in the area. In some areas this proportion made it difficult to ensure adequate representation of non-domestic consumers, and under the new Act the minimum proportion is to be two-fifths. In addition, the Councils are in future free to consider

British Electricity Act, 1957

any matter affecting the variation of the bulk supply tariff for that area. This last sounds fair enough (since retail tariffs are closely related to bulk supply tariffs and can hardly be considered effectively without them) but how is it going to work out ? Tariffs can be a complicated business and can hardly be understood by a lay committee without some technical assistance. In discussing the retail tariffs in an area such assistance was forthcoming, and the Board making the tariff proposals could always supply officers to explain and justify their proposals. But the bulk supply tariff is a national formula and it is not so easy to establish a liaison between those in London who constructed it and those in an Area Consultative Council who perhaps wish to object to it.

The Act places a new obligation upon the Boards, the Electricity Council and the Minister to take into account the effect which new projects may have on the preservation of amenities. There are new provisions governing the procedure to be followed before power station and overhead line projects receive statutory consent, whose object is to ensure that individual and special interests shall receive proper attention.

Finally, who will be the members of the new Generating Board and the outside members of the Electricity Council ? The range of choice will at least have been made a little wider by the Govement announcement (in line with the Herbert Committee recommendation) that the salary ceilings were to be raised. Much of the Act's success will depend upon a wise choice.

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Editorial

Indus Waters Again

The protracted negotiations for over three years between India and Pakistan to resolve the "Canal Waters Dispute" under the good offices of the World Bank on the basis of division of the rivers has finally broken down. But fortunately the World Bank is continuing in its persevering efforts and it is understood that it has now offered fresh proposals. Before we go into that question it may be interesting to note that the cause of the breakdown is mainly the acute distrust between the two countries to such an extent that although the entire rivers were being considered for division between the two countries they could not agree to such a minor detail as the cost of compensation.

In a way the failure to agree on clear division of rivers between the two neighbouring states may turn out to be a blessing in disguise. For the basis of the new proposals consists in the fact that neither country would have the exclusive use of the three rivers allotted to each side. This means that either country will remain dependant on the other for actual supplies of irrigation waters, whatever may be the financial basis of the transaction.

The World Bank has suggested that Pakistan should receive 10 million acre feet of water on account of its "historical withdrawals". But she has already built link canals to replace about 50% of this water and the Bank has now suggested that she could receive the remaining 5 million acre ft of water from the three eastern rivers. To compensate India for the loss of these 5 million acre ft. of water from the eastern rivers, it has been proposed that this quantity of water should be given to India from one of the western rivers and the suggestion is that the Chambal river should be tapped for this purpose, possibly, at a high altitude in Himachal Pradesh.

Thus it will be noticed that the two countries' interests will remain interlocked perenially and they will be forced to collaborate for mutual benefit, or alternatively, a harm caused by one can be reciprocated by the other.

In the earlier proposal, which feel through, an attempt was made to divide the interests of the two sovereign states in the Indus Basin in a clear-cut manner. In the present set up now under investigation there is an element of mutuality and interdependence. It is because of this element that we heartily welcome the proposal as a step in the right direction, although in our opinion the principle has not been applied to the fullest extent.

It is reported that both India and Pakistan have indicated their argeement to the new proposals in principle. That itself is a great step forward, if the implication of perenial interdependence has been consciously accepted. But there is a lot of gap between the acceptance of the principle and its adoption as a policy, particularly in the case of India and Pakistan. One therefore need not be unduly optimistic. We hope that the sincere efforts of the Bank will fructify at the end although there is a lot of difficult negotiation to go through.

* * * *

Power from Nuclear Fusion

On January 24th Britain made a very important announcement, namely, the production of temperatures as high as 5 million degrees centigrade. This has been possible by working with a strange doughnut shaped machine called Zeta (Zero energy thermonuclear assembly). Though it was pointed out that it will be many years before the new power can be applied to practical uses, the present achievement is something fundamental in character. This will help in production of power from the hydrogen contained in the sea water and will thus be able to supply the world's energy requirement for all times.

The first problem facing the team in the General Physics Division of the Harwell Establishment was that it is much easier to split an atom, the present source of atomic energy from uranium, than to make it fuse with another of its kind. The nucleus of one atom has a natural revulsion to the nucleus of another. The only way was to take a lesson from the Sun, where fusion is going on all the time, and force the nuclei together by means of great heat.

Zeta—in effect a "man-made sun"—was the Harwell answer. The container for the heavy hydrogen gas (deuterium) which contains the atoms is a ring-shaped tube ; hence the "doughnut" appearance. An electric current is shot through the tube, making the gas collect down the middle without touching the walls. The tremendous heat generated forces the nuclei of separate atoms to combine—a process which releases great energy.

Another problem facing the scientists was how to keep the hot gas from touching the walls and thereby immediately losing temperature. They solved this by applying a magnetic field round the column of gas. This fenced it in and kept it steady in the middle of the tube long enough for fusion to take place. "Long enough" amounted only to periods lasting less than a wink—two to five-thousandths of a second. The heating process was repeated every ten seconds.

Before sufficient thermonuclear energy for practical purposes can be generated in the future, it is estimated temperatures will have to be stepped up to 50 million degrees centigrade (the centre of the Sun has a temperature of 10 million degrees centigrade) and the heat, instead of lasting for only a small fraction of a second, will have to be sustained for several seconds.

But the scientists are confident this can be done. The Atomic Energy Authority report said : "There appears to be no fundamental reason why these longer times, together with much higher temperatures, cannot be achieved."

* * * *

Utilisation of Irrigation Waters

In our November, 1957 issue we had discussed the subject of inadequate utilisation of irrigation facilities offered by the completion of large projects. Since then Mr. A. P. Jain, the Food Minister of the Union Government, has expressed himself on this issue. He suggested that even if we have to supply water at nominal rates "to ensure full utilisation, we must adopt that policy." One of the causes of the shortfall in this respect according to him, is that "the distributory and irrigation channels had not either been built or in some cases had given way.' This partly confirms our apprehensions that all phases of a project are not given smiultaneous attention.

But apart from the blame that the government machinery has to share, a significant aspect of the failure lies in the lack of fuller appreciation of the potentialities of irrigation agriculture by the cultivators. In this respect it is more the responsibility of the agricultural department's organisation, of the Community Development organisation and of the local leadership, political and social. In this context we might make a reference to Mr Baleshwar Nath's article published in this issue. It appears he relies, too much on government organisations. If the present cumbersome governmental apparatus is not able to discharge its responsibilities it has already undertaken, would it be proper to load it with such a widespread task as he suggests ?

To us it appears, there are two aspects of the matter. One is to entrust on and encourage the available local leadership to educate the farmers and to demonstrate the improved methods of irrigation-farming. And the other is to promote cooperative and self-reliant local organisations to undertake improved agriculture. The place of the Government here would be to help and suggest and advise. In this context the Gauhati resolution of the Congress is a welcome guidance to local leaders in the rural areas and we hope they will undertake some real constructive activities, forgetting their partisan loyalties for the moment.

Electric Meters and Component Parts

Production at G.E.C. Behala Factory

MR. J. S. CARTER

India is expected to be self-sufficient by the end of this year to the extent of 80 to 85 per cent of component parts and materials in the manufacture of electric meters in this country. Mr. J. S. Carter, Managing Director of Chamberlain and Hookham Limited of Birmingham, said in Calcutta of Friday, January 17, 1958.

Mr. Carter, who claimed to have had the experience of seeing the designing and manufacture of meters for the past half a century, was speaking at a reception given him by the General Electric Company of India at its Paharpur Works on Taratolla Road, Behala.

Meters, for installation in private houses, were now being manufactured on a big scale in Calcutta and elsewhere. At the moment more than two lakh meters were being produced in India, as against the annual requirement of about half a million. Mr. Carter believed that India would become self-supporting within the next two years.

For British manufactured meters, he felt, the Indian market was fast declining, although the market for British-made meters was growing elsewhere, as in Malaya. Mr. Carter said that British manufacturers should help India in the attempt to become self-supporting. In spite of the Indian market rapidly growing for indigenous products, he hoped there would still be a good market for special types of meters.

Mr. Carter and other guests present were shown round the GEC Paharpur Works, where, according to Mr. Carter, meters of high quality and accuracy were now being produced. This year (1957-58) the GEC factory would produce something like 50,000 meters. Next year (1958-59) the production was expected to be doubled.

Our Contributors

J. BAHADUR is assistant Engineer in the Kosi Project Administration.

BALESHWAR NATH is Secretary of the Central Board of Irrigation and Power and is a frequent contributor to our journal.

A.E.I. in India's Development Projects

By H. C. HARDY

Among the basic requirements of economic development, the generation and distribution of electrical power has benefited from the contribution made by the A.E.I. organisation, backed by the considerable technical resources of the constituent companies.

From the beginning of development in India of high voltage technique, A.E.I. have studied the suitability of the plant supplied by them for the onerous climatic conditions to be met in India and in many instances, details of design incorporated in the electrical apparatus have been influenced by the Indian operating requirements.

In addition to supplying equipment, consulting services have been rendered in the case of many projects, particularly in the early stages of development. Such services comprise electrical system studies, load surveys and design of complete electrical projects. The aggregate capacities of the more important types of equipment so far supplied to, or on order from the different electricity undertakings illustrate the part played by this Company in furthering electrical development in India.

Waterwheel generators of an aggregate capacity exceeding .8 million kW.

Thermal power plants of about .68 million kW (both State and private owned).

Transformers of over 1 million kVA.

About 500 outdoor oil circuit breakers for voltages 33-kV and above.

The contribution of Messrs Associated Electrical Industries Manufacturing Co. Private Ltd., is also significant. Many transformers and about 2500 outdoor type gang operated isolating switches for voltages in the range 3.3 kV to 132 kV have been supplied by Associated Electrical Industries Manufacturing Co. for various electrification projects, also large quantities of motors and transformers for industrial use.

In point of fact, whether the gigantic Damodar Valley Project, Bhakra-Nangal in the East Punjab, Hirakud in Orissa, Khaperkheda Thermal Scheme in Madhya Pradesh, Machkund in Andhra, or the modest Duduma Transmission Scheme in Orissa, North Calcutta Rural Electrification Scheme in West Bengal, to mention only a few, there is hardly any electrical scheme included in the first Plan in which this Company did not participate, in one way or other. The following is a very brief account of the association of this Company with some of the many power projects which were included in the first Plan.

Of the several hydro-electric projects in which this Company participated, the Hirakud Project in Orissa may be particularly mentioned. Apart from the supply of complete indoor and outdoor switchgear for the power station, comprising British Thomson-Houston power transformers, ranging from 2 to 42 MVA, voltage ratios 132/11-kV, 132/66-kV, 66/11-kV, with an aggregate capacity of 167,000 kVA, large numbers of Metropolitan-Vickers 132 kV and 66 kV oil circuit breakers and A.E.I.M. gang operated, outdoor type, isolating switches, the outdoor switching station as well as the supporting structures were designed by this Company. Erection, testing and commissioning of the plant supplied, under expert supervision, were also undertaken by the Company.

In the field of thermal power, of the many schemes which this Company executed, the first stage of the Khaperkheda Thermal Scheme and the Grid Substations in the State of Madhya Pradesh, deserve mentioning. For the Khaperkheda Power Station, three 10,000 kW steam turbo-alternator sets of M/s. Metropolitan-Vickers manufacture, complete with all auxiliaries and power station switchgear, were supplied by this Company. For the Grid Substations, which were completely engineered by this Company, the equipments supplied include Metropolitan-Vickers power transformers ranging from 500 to 12,500 kVA, voltage ratios 66-kV/11-kV, total kVA 85,000, outdoor and indoor switchgear manufactured by M/s. Ferguson Pailin Ltd.; complete erection, testing and commissioning also being carried out.

There is yet another field, namely, electric traction, with which this Company has been actively engaged since its inception in India. In recognition of the Company's specialised experience in this regard, an order was received for equipments pertaining to the Railway Electrification Project of the Howrah-Burdwan main line and Tarakeshwar branch line. The order comprises of thirty-six complete sets of 3000 volt D.C. traction equipment for 3-car trains,

each having one 840 h.p. motor coach and two trailer coaches, six 3000 volt rectifier substations (total capacity 32,000 kW) comprising twelve pumpless, air cooled, steel tank rectifiers, fiftyone D.C. high speed circuit breakers and auxiliary plant, four 3000 volt track sectioning cabins, having a total of twenty-two D.C. high speed circuit breakers and associated equipment.

The equipments are designed to permit a maximum speed of 65 m.p.h. on level track with a fully loaded train and a starting acceleration of 1.2 m.p.h. per second up to 25 m.p.h. Worthy of particular note is the fact that approximately 15 percent of the traction equipment is being manufactured in India. This manufacture is being carried out by Associated Electrical Industries Manufacturing Co. to the designs of Metropolitan-Vickers. This is the first occasion on which electrical traction equipment has been manufactured in India, and represents a substantial and welcome saving in foreign exchange.

The fixed equipment, i.e. rectifiers, transformers, etc. have been manufactured by the British Thomson-Houston Co. and here again the local manufacture of some of the high speed D.C. circuit breaker equipments has been carried out in India.

Among the several electrical projects under the second Plan, with which the Company is associated, one example is the Bhakra Power Station in East Punjab.

The Bhakra Dam and Power Plant are located on the Sutlej River in the Bhakra Gorge, and the site is approximately 215 miles north of Delhi, the national capital.

With the 680 ft. high Dam, which is the biggest straight gravity Dam in the world, together with a large mileage of canals, the Bhakra Project is the largest multi-purpose project in India.

The salient features of this project are :—

(1) Construction of the Dam 680 ft. high.
(2) 2 Power Houses, one on either side of the Dam.

At present work has been taken up on one power house which will be constructed on the left bank of the Dam, in which will be located 5 generating units each of 100,000 kVA capacity. These are the largest machines to be installed in India. Order for these generators, Automatic Voltage Regulators, protective gear and other auxiliary equipments has been placed with Metropolitan-Vickers Export Co. Ltd., Manchester, through Messrs A.E.I. (India) Private Ltd., and the first machine is expected to be shipped by the middle of this year and to be completed by the end of 1959.

At present, the Dam has risen to roughly half its final height and considerable progress has been made on the construction of the Power House.

Major portion of the power from this station is expected to be supplied to Nangal Fertiliser Factory, which is to be located about 6 miles from this Power House. The remaining power will be available for distribution to Punjab, Pepsu, Rajasthan and Delhi, and the main transmission voltage is at 220,000 volts, the highest voltage envisaged in India at present.

The technical and financial aspects of this project are being controlled by a special board with the Governor of Punjab as the Chairman.

"Dry Cooling Towers"—Important Power Station Development

The English Electric Company is developing a cooling system for power stations which makes it possible to site them in areas where large volumes of cooling water are not available, or can only be provided at excessive cost. The announcement that negotiations were in hand for the design and construction of a commercial scale installation was made recently by the Central Electricity Authority, U.K.

The "dry cooling tower" plant uses a system proposed by two Hungarian engineers, Prof L. Heller of Budapest University, and Mr. L. Forgo, in a paper delivered at the last World Power Conference in Vienna.

Up to the present, the only practical method of condensing the steam in large plants has been by passing large volumes of cooling water through surface condensers, which has normally restricted siting of power stations to rivers, lakes and coasts. The essential features of the new scheme are the injection of pure water into the steam and the cooling of the mixture of water and condensate by air in large heat exchangers, or coolers, of special design fitted round the base of the dry cooling tower. In the new system the initial supply of water is used again and again, with only comparatively slight losses to be made up.

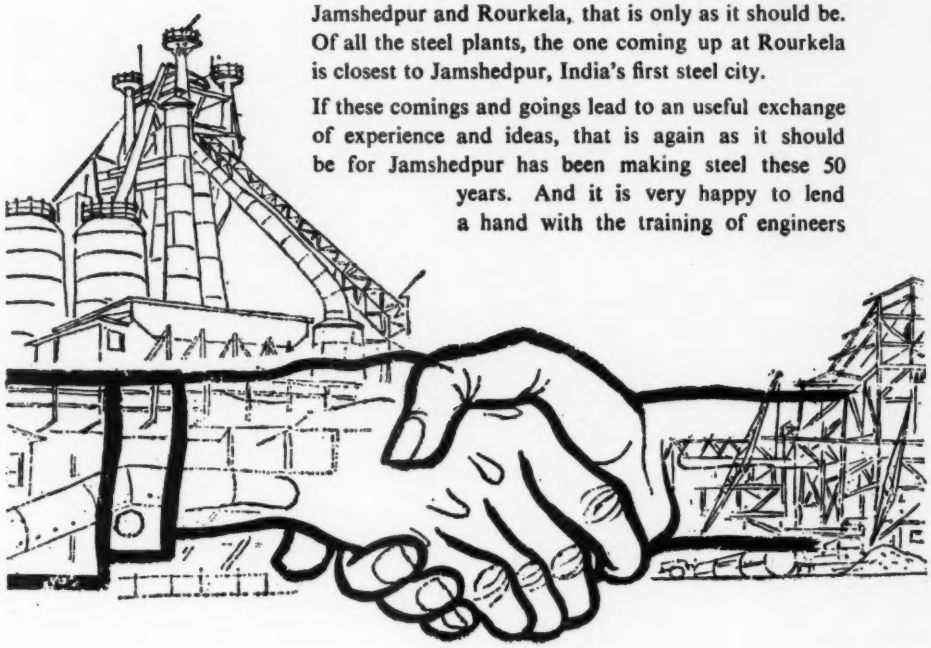
Since the system is completely closed the water in circulation will be of condensate purity, and the plant will therefore be free from internal corrosion troubles. The flow of air through the cooler is produced by either induced draught fans or natural draught, the choice depending on such factors as fuel cost, atmospheric temperature and size of unit.

Two factors contribute to the overall economy of the scheme—firstly, the cooler, which is made entirely of aluminium and is simple, effective and cheap to construct, and secondly, the incorporation of the spray condenser, which eliminates the drop in temperature between the condensate and cooling water that occurs in the conventional condenser.

Because an economic study is necessary in each particular case, no generalisation about overall costs is feasible, but the Company states that its studies indicate that as soon as cooling water becomes a special problem for any reason, the scheme will quite frequently be overall more economical than the normal systems. When it is desired to site a station at a distance from natural sources of cooling water, the dry cooling tower provides a technically sound and potentially economic solution.

The initiative of the Central Electricity Authority in encouraging this development may have important economic repercussions by extending the field of thermo-electric generation to territories where cooling water limitations would make normal installations impossible.

From a Neighbour



If there is a lot of comings and goings between Jamshedpur and Rourkela, that is only as it should be. Of all the steel plants, the one coming up at Rourkela is closest to Jamshedpur, India's first steel city.

If these comings and goings lead to an useful exchange of experience and ideas, that is again as it should be for Jamshedpur has been making steel these 50 years. And it is very happy to lend a hand with the training of engineers and technicians for Rourkela. There are nearly 150 of them at Jamshedpur—from key personnel to artisans.

Good Wishes to Rourkela

Strengthening these ties of friendship are the surprisingly large number of old Jamshedpur faces that one sees at Rourkela. To them and their colleagues, Jamshedpur sends neighbourly greetings and good wishes.

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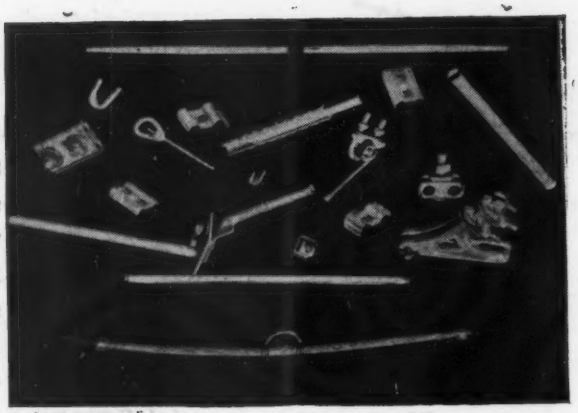

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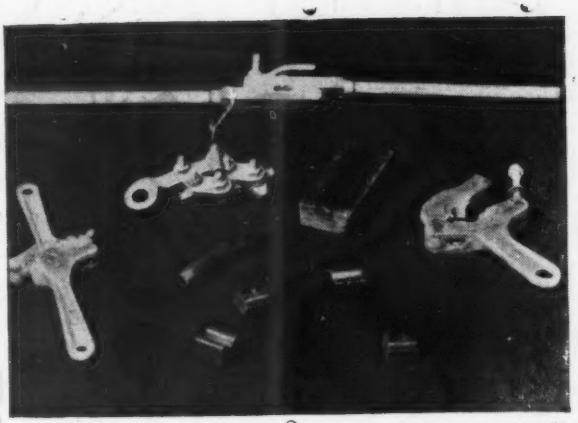

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